POWER

Vol. 39 NEW YORK, MARCH 24, 1914 No. 12

They Also Serve

DON'T WITHHOLD THE CREDIT THESE CHAPS DESERVE

When we are pitying ourselves for all the hardships we have to undergo in this trying winter weather to keep the "juice" in the line so that others can get to their homes and there enjoy light and comfort, let us not forget that there are others who suffer and sacrifice for the public weal in still humbler positions.

And, another thought! If these horses could talk, wouldn't they say, "Do make this load last as long as you can?" Coal economy has its humanitarian element, also; at times.

Continental Motor Mfg. Co.'s Power Plant

By Harry C. Spillman

SYNOPSIS—A 900-kv.-a. capacity plant containing features not generally found in a plant of its size. Vertical boilers supply steam to two engines. Coal is handled by a monorail grab-bucket system. The finish of the engine room is out of the ordinary.

The new power plant of the Continental Motor Manufacturing Co., Detroit, Mich., has a number of interesting features for a plant of 900 kv.-a. capacity. Every detail has been carefully worked out to make the plant economical in operation and attractive in appearance. The architecture of the building, Fig. 1, was given considerable thought and it is, figuratively speaking, built around the equipment. The building is made fireproof by structural steel framework encased in masonry, steel sashes, reinforced concrete and tile floors and a concrete roof supported on I-beams. It is flooded with daylight by large windows reaching nearly to the roof which can be opened and closed with sash operators. The exterior is made attractive by using pressed brick and the clever introduction of cement-plaster panels worked in the masonry.

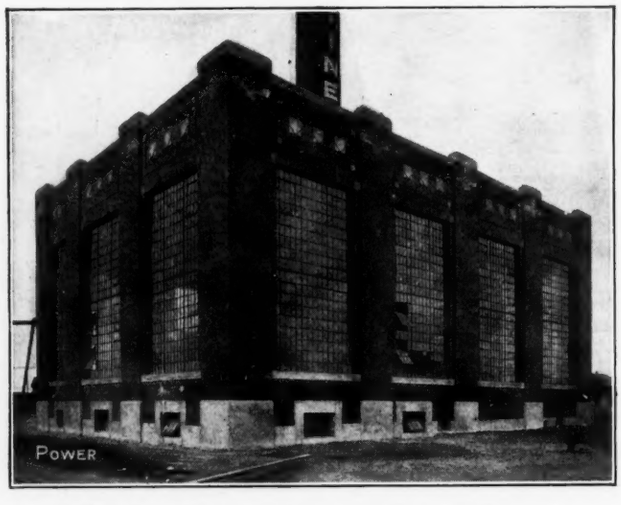


Fig. 1. Exterior of the Power Plant

The 150-ft. stack is designed to take care of the future growth of the plant, having an internal flue 8 ft. 6 in. in diameter. It is of reinforced concrete with an exterior and interior facing of dark-brown glazed tile capable of withstanding 1200 deg. F. without cracking, and has a cast-iron cap. This style of chimney has all the advantages of the reinforced-concrete stack with the attractive features of a tile chimney. The word "Continental" is laid in white enamel tile which project 1 in. beyond the face of the stack; this projection allows the rain to strike the letters and keep them clean.

Boiler Room

There are three vertical water-tube boilers, each having 2500 sq.ft. of heating surface, and steam is generated at 150 lb. Each boiler is equipped with a mechanical stoker designed to burn bituminous nut, pea and slack coal. A soot blower is also attached to each boiler for cleaning boiler tubes.

Two 10 and 6 by 12-in. steam-driven, duplex, outside center-packed plunger pumps designed for 250 lb. working pressure supply the boiler-feed water. Each pump is fitted with a force-feed cylinder lubricator, and the pumps discharge into a 6-in. feed line with feed valves located at a central point.

Coal is handled by a cab-operated, monorail conveyor, and single-rope grab bucket with a capacity of 1200 lb. of coal; see Fig. 2. The runway continues for 22 ft. beyond the power house and is supported on a trestle which spans the railroad siding. This allows the monorail conveyor to unload the cars and either store the coal in the yard or deposit it in the metal bins over the boilers. A switch on the monorail track permits the same conveyor to take care of the ashes, which the fireman pulls into the large pits located in front of the boilers.

Piping

All piping was designed with ample allowance for expansion and future extension of the plant. The accessibility of the valves and all fittings was given careful thought and special iron gratings are installed wherever necessary to carry out this scheme. Metal gratings with ladders are also installed around the water columns of the boilers.

The steam header is supported from the fire wall near the top of the boilers and runs the length of the boiler room. The ends turn down into the basement where they connect, making a loop system. Valves are placed at intervals in the header, which allows any section to be shut off for repairs without interfering with the operation of the plant. The branch lines for the engine room are taken from the header in the basement. This makes a flexible arrangement and the steam loop can be easily extended with the growth of the plant.

Fig. 2. Monorail Coal Conveyor

All drip pipes are connected to steam traps which discharge into a feed-water heater placed near the stack in the boiler room. The exhaust from the two engines and auxiliary equipment leads into a 24-in. exhaust line. One 12-in. branch is connected to the 1500-hp. feed-wate

heater and the 16-in. branch feeds the vacuum-heating system. The blowoff piping is also located in the basement with the extension stems on the valves projecting through the boiler-room floor.

As indicated by Fig. 3, the engine room is free from piping, wires, pumps and other auxiliary equipment. It contains only the generating units, exciters and switchboard. The floor is covered with 6x9-in. red quarry tile laid in white mortar and the side walls are wainscoated with white enamel brick 6 ft. high, with pale-yellow pressed brick above. The engine pits are lined with 3- and 6-in. white bathroom tile and the sub-bases of the engine above the floor line are covered with 3x6-in. red tile laid with tight joints. The railings are of steel tubing enameled black with polished brass fittings, and the equipment is painted a light pearl gray to harmonize with the surroundings.

Unit No. 1 is a 20 and 30 by 36-in. cross-compound, heavy-duty Corliss engine, running at 120 r.p.m., directly connected to a 500-kv.-a. generator. Unit No. 2 is a 19 and 20 by 27-in. horizontal, side-crank, cross-compound engine directly connected to a 400-kv.-a. generator running at 150 r.p.m., and is equipped with nonreleasing multi-ported Corliss valves. Both generators are three-phase, 60-cycle, 240-volt, alternating-current machines and are guaranteed to carry a 50 per cent. continuous overload without injury.

Excitation is maintained by a 25-kw., 125-volt, direct-connected, turbo-generator unit, running at 3500 r.p.m. It is used for starting only and after the main units are in operation the excitation is thrown onto a 125-volt motor-generator set, of 40 kw. capacity This exciter also furnishes the necessary direct current for the magnetic chucks and storage batteries in the factory.

Both engines are furnished with a continuous supply of oil from a gravity-oiling system which filters the oil and automatically returns it to a gravity tank by means of a small steam pump.

The engine-room floor is spanned by a 15-ton hand-power traveling crane, having a 25-ft. lift and a two-speed hoist and automatic brake. Cables are used on this crane instead of chains.

Switchboard

The leads connecting the generators to the switchboard are made up of ¼x4-in. laminated copper bars covered with tape and supported on brackets. Each generator panel has an alternating-current ammeter in each phase, a voltmeter with a three-point switch, one indicating wattmeter, a direct-current ammeter for the field circuit, and a recording wattmeter, besides the necessary switches.

Two panels are given up to the power feeders; each building having a separate circuit for power which is protected by a three-pole, double-coil, circuit-breaker, non-closable on overloads.

The lighting circuits are located on the end panel. Each circuit has a three-pole, single-throw switch with a fuse panel on the rear of the board. By means of balance coils, 110-volt, single-phase current is used for illumination. The exciter panel carries a direct-current voltmeter with a plug switch, two direct-current ammeters and the necessary switches.

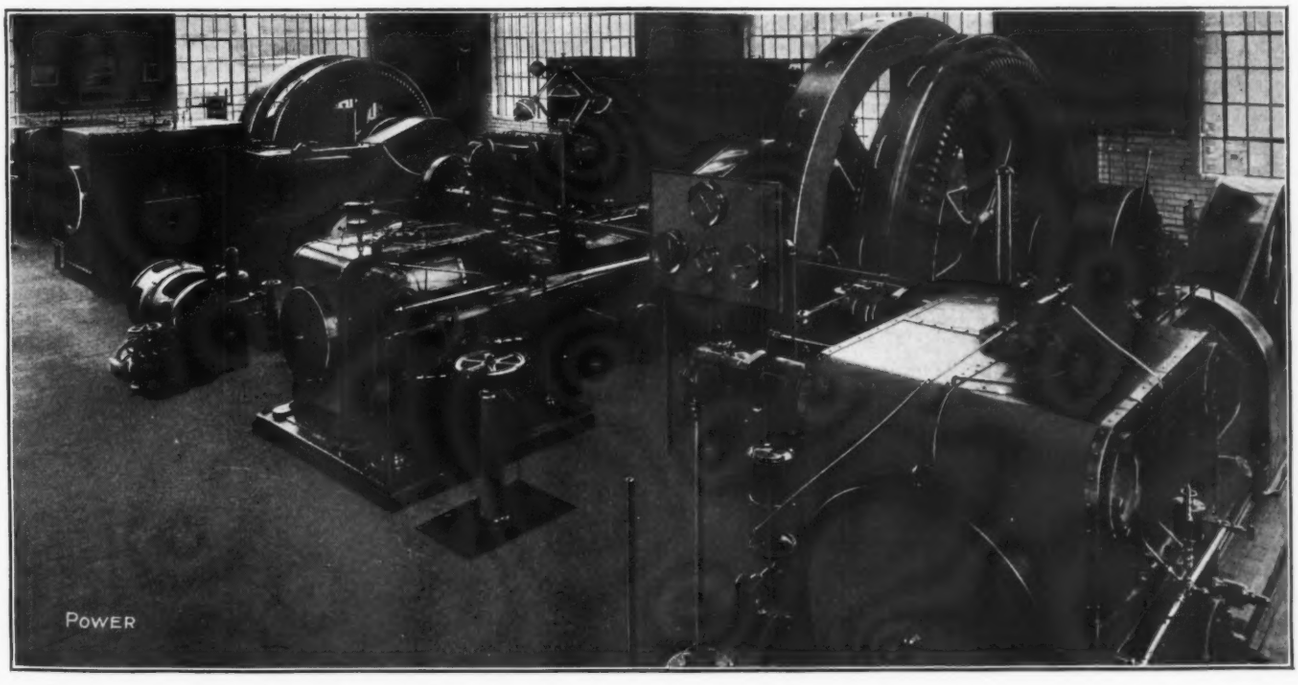


Fig. 3. General View of the Engine Room, Showing Absence of Piping

The plant is illuminated with Cooper-Hewitt lamps having red reflectors which changes the green rays to a lighter shade and makes an excellent illumination. Floor and wall outlets are scattered throughout the plant, allowing the use of extension lamps when making repairs.

The entire equipment was purchased under high efficiency guarantees. The stokers and boilers are covered with a guarantee to evaporate 10 lb. of water from and at 212 deg. F., with bituminous nut, pea and slack coal containing not less than 13,500 B.t.u. nor more than 8 per cent. ash. The Corliss engine has a guarantee that the steam consumption will not exceed 20 lb. per i.hp when operating at full load. The other engine is guaranteed to work at full load with a steam consumption not exceeding 17.9 lb. per i.hp. Both generators show an efficiency of 94.5 per cent. at full load.

Engine-Turbine Units or Straight Turbines

By Charles H. Bromley

SYNOPSIS—An interview in which Mr. Stott tells which class of prime mover—high-pressure turbine or reciprocating engine-low-pressure turbine—would be more economical in a new plant. Why low-pressure turbines were installed in the 59th Street Station and high-pressure turbines were selected to displace the reciprocating engines at the 74th Street Station.

Since the installation of the low-pressure turbines connected to the 7500-kw. angle compound engine at the 59th Street Station of the Interborough Rapid Transit Company, of New York, much interest, both here and abroad, has centered in these combined units. It is the high economy of these prime movers that has excited interest. The fuel consumption per kw.-hr. of the combined unit is less than 2 lb. of coal having 14,500 B.t.u. The installation and remarkable results obtained at this station, and the knowledge that reciprocating engines were to be scrapped to make way for three 30,000-kw. high-pressure turbines at the 74th Street Station of the same company, has caused many to inquire: Why, with the extraordinary results obtained with the combined units at the 59th Street Station, were complete expansion or high-pressure turbines selected for the 74th Street Station? What would be the more economical unit to install in a new plant, combined engine-low-pressure turbine, or a high-pressure turbine?

In a paper on the selection of prime movers, read befor the joint meeting of the New York members of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Electrochemical Society, H. E. Longwell, referring to Henry G. Stott, superintendent of motive power of the Interborough Rapid Transit Co., said: "If Mr. Stott would be willing to say whether or not in an absolutely new plant he would seriously contemplate the installation of combination reciprocating engines and low-pressure turbines, such a pronouncement would be far more convincing than volumes of arguments based purely on theoretical grounds."

With these questions in mind, I asked Mr. Stott to express, through Power, the opinion for which Mr. Longwell wished; and to explain the considerations which had led to the failure to repeat at 74th St., the course which had been so successful at 59th St.

Mr. Stott says that a complete expansion turbine will prove most economical for a new plant because its first cost is much lower than that of a reciprocating engine-low-pressure turbine unit, and because the maintenance and operating charges are less. Complete expansion turbines (turbine and generator combined) of large power —20,000 kw. or so—may be purchased for $8 per kw., the price increasing as the capacity of the unit becomes less. Combination reciprocating engine-low-pressure turbine units of large power will cost in the neighborhood of $40 per kw. The interest on the capital invested is, therefore, considerably higher in the case of the latter kind of unit. Obviously, the cost of attendance, supplies and maintenance will also be greater.

The steam consumption of the combined units at 59th Street Station is about 14.2 lb. per kw.-hr., and during the test* reported by Mr. Stott, the overall efficiency, as shown by one test, was 72½ per cent. of the total available energy between the steam entering the engine and the recorded exhaust pressure of the turbine. This was an improvement in economy of 13 per cent. over the best high-pressure turbine results obtained at that time (1909). In this connection, the prediction of O. Junggren, turbine engineer of the General Electric Company, in commenting on Mr. Stott's paper, that "a high-pressure turbine would be considerably cheaper than the combined unit, and, in the near future, high-pressure turbines will be made having as high efficiency as the combined unit and still be cheaper than a combination of engine and turbine" is interesting.

Mr. Junggren knew what he was talking about, for the guaranteed steam consumption of the 30,000-kw. turbines for the 74th Street Station is 11 lb. per kw.-hr. at 150 deg. F. superheat. Such an increase in economy of the high-pressure turbine compared to that obtained with such units contemporaneous with the installation of the low-pressure turbines at 59th Street has occurred, that the question of which kind of unit would be best to install in a new plant is no longer a question. The complete expansion turbine has the advantage, as Mr. Stott says, of a much lower first cost combined with lower maintenance and operating costs. So much for the selection of a prime mover for a new plant.

As far back as 1908, the rapidly increasing traffic in the subway made necessary much additional power to be available during the winter of 1909-10. Space admitted installing three high-pressure turbines, each with a capacity (7500 kw. maximum) equal to that of each engine, or of connecting a low-pressure turbine to each of the nine engines. So space or real estate values were not determining factors in the selection of prime movers to meet this increased demand. The saving in investment, made possible by using the reciprocating engines, was the chief determining factor. These engines were in excellent physical condition. They were designed for 200 lb. pressure, and the 42-in. horizontal high-pressure cylinders are provided with poppet valves which are capable of handling high pressure and temperature without distortion. With these valves, the steam leakage is less, and there are fewer lubrication troubles than with large Corliss valves. The high initial pressure and the ability of the engine to successfully use it, made the low-pressure turbine inevitable for this station, considering the saving on the capital invested to secure the increased capacity.

All this is not true of the 74th Street Station. The engines were designed for an initial pressure of only 160 lb. All of the cylinders have Corliss valves, which are

*"Transactions," American Society Mechanical Engineers, 1910, Vol. 32, pp. 69-135.

very large and subject to the troubles mentioned. The engines are in a much less perfect physical condition than those at 59th Street. Space is valuable and limited at the 74th Street Station, and the needed increase in capacity is such that a low-pressure turbine installation is disadvantageous both because of lack of space and because of the comparatively low initial pressure for the engine. The high-pressure turbine, therefore, is better adapted to the conditions, because it is more economical, more compact, capable of using high superheat and the operating and maintenance charges are less than with the engine-low-pressure turbine unit.

The state of the art of engineering, the physical condition of the engines, available space—all favored the low-pressure turbine for the 59th Street Station, while they prohibit it for the 74th Street Station.

Testing Engines in Office Buildings

By W. L. Durand

In many modern city-building power plants the engines are rarely tested after they are installed. In some instances the lack of facilities makes it impossible to test the engines for steam consumption without considerable preparation. In other cases where it might be possible to test one engine with the rest of the plant idle, it is not feasible, as when the engines are ready the demands require that one or more be kept running.

Reliability of service is of such importance that it is necessary to duplicate the plant in the most essential features. Where this is done it is easy to so arrange the piping that the engines and boilers may be run as two independent plants; with one pump, one boiler and one engine arranged for testing and the other pump and the rest of the boilers and engines for carrying the building load. The units forming these combinations can be varied as desired so that all of the engines can be tested. One method of arranging the steam- and boiler-feed piping is shown in Figs. 1 and 2.

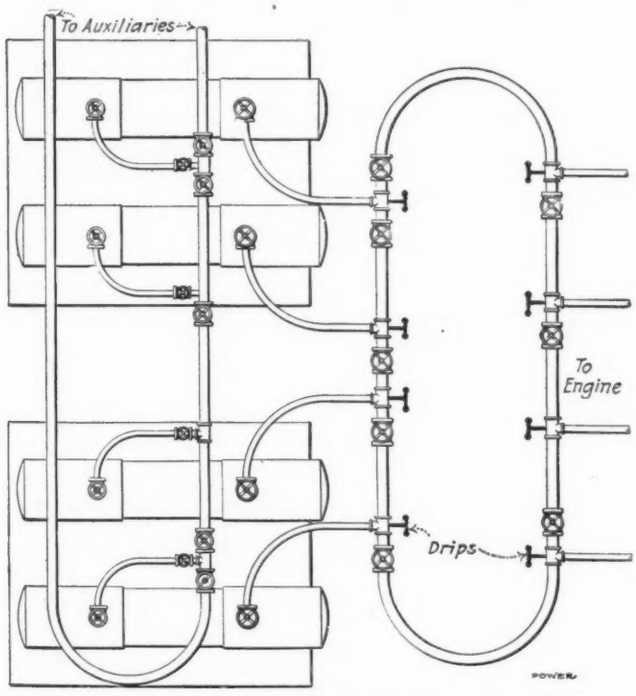


Fig. 1. Boiler-Room Piping

The easiest and most accurate means of weighing the water is by the two-barrel method. From the lower barrel a line is run to the suction side of the feed pumps, both of which should have a globe valve with which to connect. The water level in the boiler should be at the same level at the beginning and the end of the test, and the amount of condensation in the steam piping should be determined and subtracted from the total amount of steam to obtain the correct amount delivered to the engine.

This may be done without interfering with the operation of the drips from the rest of the plant by arranging drip piping as a part of the permanent equipment so that it is possible to test an engine at any time.

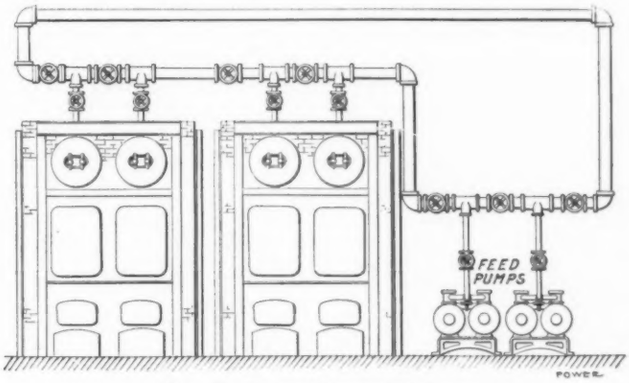


Fig. 2. Feed-Water Piping

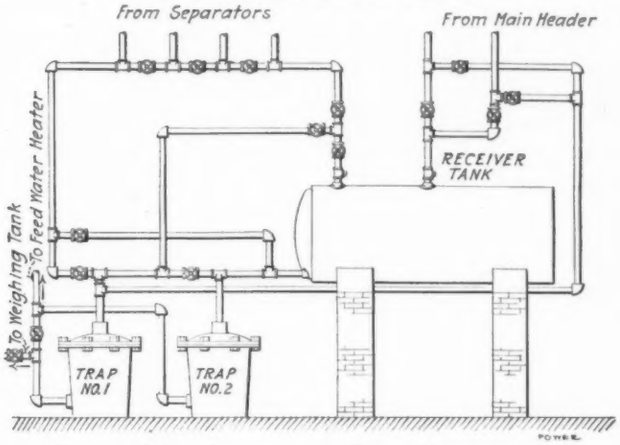


Fig. 3. Drip Piping for Line Condensation

As in Figs. 1 and 3, each half of the header is dripped and a separate line is run to the receiving tank; a separate line is also run from each engine separator. Trap No. 1 has a valve from which connection to a tank on a scale may be made. In making the test the drips from the half of the header and from the separator on the engine under test are run to trap No. 1 and weighed; the drips from the other engines and half of the header go to trap No. 2 and are discharged into the feed-water heater. In Fig. 3 it may be seen what combinations of valves are closed in order to operate the system.

To Find the Number of Integer Places in a Product or Quotient

By F. R. Low

When using a slide rule or calculating machine one cannot always point off in the usual way, because the right-hand end of the answer is often lacking, and it is desirable to be able to point off from the left-hand end,i.e. to set off the integer instead of the decimal places. In applying the following rules count as having a minus number of integer places those which have, so to speak, less than none; thus

78.54	has	2 integer places	0.07854	has — 1 integer place
7.854	has	1 integer place	0.007854	has — 2 integer places
0.7854	has	0 integer places	0.0007854	has — 3 integer places

Notice that the minus figure is indicated by the number of 0's between the first figure and the decimal point; as 0.**00**7854 = — **2** because there are two 0's between the 7 and the point. The "first figure" of a number, as used in the following rules, means the first left-hand figure other than 0; as the 7 in all of the above instances. When "first figures" require to be compared and are identical, compare the first two, as in the second example under the first rule. If the first two are alike take in the 3d, etc.

In order to avoid repetition let me indicate by "sum" the total number of integer places in both factors; and by "difference" the result obtained by subtracting the number of integer places in the divisor from that of those in the dividend. This last quantity may be minus. In adding and subtracting the plus and minus quantities remember that in addition you take the sum of the two quantities only when they have the same sign, giving that sign to the sum; but if they have different signs you take the difference for the sum, giving to it the sign of the greater quantity. Thus the sum of + 2 and — 5 = — 3. In subtraction you change the sign of the subtrahend, or quantity to be subtracted and proceed as in addition. A number which has no sign is plus.

We will also indicate by *n* the number of integer places in the product or quotient.

MULTIPLICATION

When the first figure of the product is LESS than that of the factor having the greater first figure, **n = Sum**

999 = 3 plc	**99**9 = 3 plc	3.1416 = 1 plc	**4**.3946 = + 1 plc
11 = 2 plc	99 = 2 plc	**42**.9 = 2 plc	0.0031 = — 2 plc
10989 5 = sum	**98**901 5 = sum	**134**.77+ 3 = sum	0.0**1**36 + — 1 = sum
1 < 9 ∴ *n* = sum = 5*	98 < 99 ∴ *n* = sum = 5	1 < 4 ∴ *n* = sum = 3	1 < 4 ∴ *n* = sum = —1

When the first figure of the product is GREATER than that of the factor having the greater first figure, **n = Sum — 1**

273 = 3 plc	1001 = 4 plc	**3**.1416 = 1 plc	0.**7**854 = 0 plc
32 = 2 plc	**999** = 3 plc	29.8 = 2 plc	0.0125 = — 1 plc
8736 5 = sum	**999999** 7 = sum	**93**.61968 3 = sum	0.00**9**817+ — 1 sum
8 > 3 ∴ *n* = 5 — 1 = 4	9990 > 9990 ∴ *n* = 7 — 1 = 6	9 > 3 ∴ *n* = 3 — 1 = 2	9 > 7 ∴ *n* = —1 —1 = —2

DIVISION

When the first figure of the dividend is LESS than that of the divisor, **n = Difference**

4 plc **1**728	1 plc **3**.1416	— 1 plc 0.0**1**49
3 plc **2**31 = 7.48+	1 plc **4** = 0.7854	+ 2 plc **15**.5 = 0.00096129
1 dif.	0 dif	— 3 dif.
1 < 2 ∴ *n* = dif. = 1	3 < 4 ∴ *n* = dif. = 0	14 < 15 ∴ *n* = dif. = —3

When the first figure of the dividend is GREATER than that of the divisor, **n = Difference + 1**

3 plc **9**69	+ 2 plc **62**.34	— 2 plc. 0.00**8**23
2 plc **1**7 = 57	— 1 plc 0.0**1**8 = 3463.33+	+ 2 plc **7**6.42 = 0.00010769+
1 = dif.	+ 3 dif.	— 4 dif.
9 > 1 ∴ *n* = 1 + 1 = 2	6 > 1 ∴ *n* = 3 + 1 = 4	8 > 7 ∴ *n* = —4 +1 = —3

A consideration of why the product should have a greater number of places when its first figure is lower may serve to fix the rules in mind.

$$4 \times 2 = 8$$

Here the "first figure" of the product is *greater* than that of the factor having the larger first figure, because the multiplication of 4 by 2 leaves it still under 10 and keeps it still a 1-place number but larger than it was to start with.

So with the greater first figure the product has the lesser number of places.

$$4 \times 3 = 12$$

Here the first figure of the product is less than that of the factor having the larger first figure, because multiplying by 3 carries it over 10, but the greatest value that the first figure of this product can have is $4 \times 999\ldots$ which will be less than 4.

So with the lesser first figure the product has the greater number of places.

*1 is less than (<) 9, hence (∴) the number (*n*) of integer places in the product equals the sum of those in the 2 factors, in this case 5.

When both of the factors commence with 3 the product will commence with either 1 or 9. When it commences with 1, n = sum, when with 9, n = sum — 1.

With this exception the product will carry over whenever both factors commence with a number greater than 2; so that *whenever neither of the factors commence with* 1 *or* 2, **n = sum,** except when both commence with 3. If we have 67.49 × 78.327 for example we know offhand (since neither of them commences with a 1 or a 2 nor both with 3) that their product will be a 9-place number of which 5 will be decimals leaving 4 integers.

Both of these cases come under the general rules given at first.

In the case of division the reason for the rules is equally obvious, and being understood will enable one to reconstruct them by a trial with simple figures.

```
24)8928(3
  72
```

If, as here, the first figure of the divisor is less than that of the dividend the number (72) first subtracted from the dividend will have the same number of places as the divisor. The number of figures in the dividend still to be brought down is equal to the "difference" between those in the dividend and those in the divisor. Each of these means a place in the quotient and to their number must be added 1 for the figure already there.

So when the first figure of the dividend is greater than that of the divisor

$$n = \text{difference} + 1$$

```
36)1728(4
  144
```

```
36)1028(2
  72
```

If, as here, the first figure of the divisor is greater than that of the dividend the number first subtracted from the dividend (144 or 72) will extend under one more place in the dividend than there are places in the divisor. This leaves one place less than the "difference" still to be brought down and produce places in the quotient, and this 1 less place plus 1 for the figure already there makes the number of places in the quotient equal to the difference.

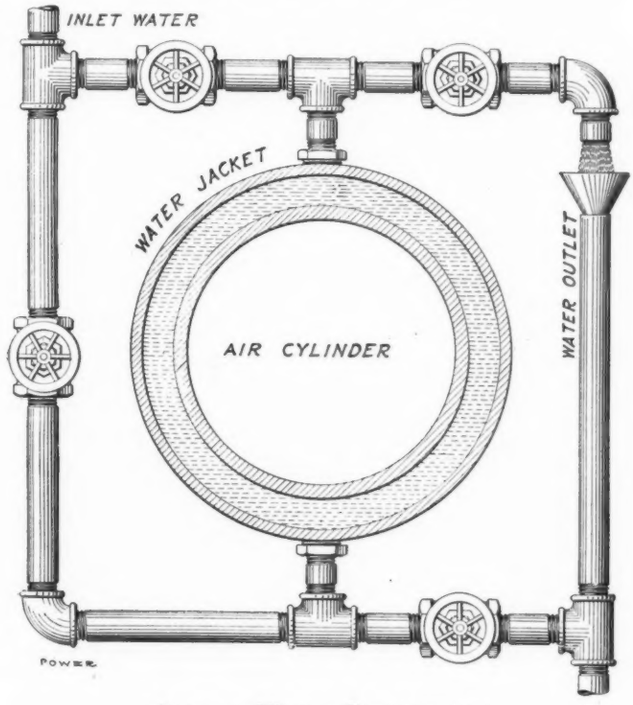
So when the first figure of the dividend is less than that of the divisor

$$n = \text{difference}$$

Air-Compressor Troubles

By A. G. Solomon

In the course of years of erecting, operating and repairing machinery of different kinds, the writer has found that usually the air compressor is neglected and abused more than any other machine in the plant.



Cooling-Water Connections

A case of poor location for two air compressors and several pumps once came to my notice in a Southern ice plant which had a light engine room containing the ammonia compressors and some smaller machinery. The air compressors and pumps had been placed outside, with no walls around them and a poor roof.

There was not much trouble until the cold weather set in. The plant was run only in the daytime, and every evening it required a good hour's work to drain the machines. The drains from the steam cylinders and valve chambers of the air compressors and pumps were piped into a 2-in. header discharging to the sewer. One morning a steam cylinder on a pump was found cracked, and it was discovered that the drain from this cylinder had become filled with cylinder oil which was thick from the cold and acted as a plug to hold back the water.

Another freeze-up was caused in an unusual way. The drains were always opened from the water jackets to let the water run on the ground. A cracked jacket was caused by sand collecting in the narrow spaces and containing enough moisture to expand when freezing. After that, the sand and sediment were loosened regularly with a bent piece of flat iron so that the water could wash them out.

A cross-connection between the water inlet and outlet will permit reversal of flow of the cooling water for a few minutes every day, thus washing out much of the sediment which would otherwise settle and perhaps cause trouble. The sketch shows the arrangement.

In compressors of the two-stage type the intercooler between the low- and high-pressure air cylinders must be watched closely for leaks in the water tubes and the gaskets. When the pressure on the cooling water is high, water will find its way into the high-pressure air cylinder and, even in small amount, it will wash off the oil and cause wear of the cylinder, the piston rings and the valves. If the water pressure is low there will be a loss of capacity, as the air will escape into the water. There

are several arrangements for intercoolers, but leakage can be looked for in any of them.

My experience with the valve setting for straight-line compressors has been varied, but I do not believe that the indicator diagrams as ordinarily taken from the steam cylinder will ever be perfect. As the power exerted on the steam piston is greatest when the least amount of work is being done, the steam valves should be set late instead of giving them lead as is the common practice.

The energy in the flywheel is sufficient to carry the machine a good ways over the center. The ever-increasing load in the air cylinder will give all the compression needed, so that the exhaust valves should be set without allowing for any compression in the steam cylinder; then the machine will be found to run smoothly with cool bearings.

I ran across an annoying occurrence in an air compressor having the suction valves in the piston. At times this machine would act as if a suction valve were broken. I opened the cylinder one Sunday and found that three of the five slots for receiving pins to hold the suction valve in place were worn to twice their original length. This caused the valve to cock sideways and stick. The pins were unusually hard and had not worn at all. Nothing could be done at the time but order a new valve sent by express.

Record in Building Large Engines

SYNOPSIS—Building a steam-driven air compressor with cylinders 48 and 84 by 60 in. in 38 days is a record. A second unit of the same size was built in 59 days. One unit required 16 cars for transportation. The engines weighed 1,800,000 lb., or 900 tons, and contained 10,210 pieces, the lightest weighing ¼ oz., the heaviest 94,550 lb.

What is believed to be the world's record in building large engines was recently accomplished by the Mesta Machine Co., of Pittsburgh, Penn., in building two horizontal, cross-compound blowing engines for the Woodward Iron Co., Woodward, Ala. The first engine was completed and loaded on cars at the Mesta works in 38 days, and the second one in 59 days from the date of signing the contract at Woodward, Ala. Each engine consists of a high-pressure and low-pressure steam cylinder 48 and 84 in. in. diameter, and two air cylinders 84 in. in diameter; stroke, 60 in. The Mesta new type of horizontal, cross-compound blowing engine, Fig. 1, is equipped with their new automatic plate valves (Iversen patent) as shown in Fig. 2.

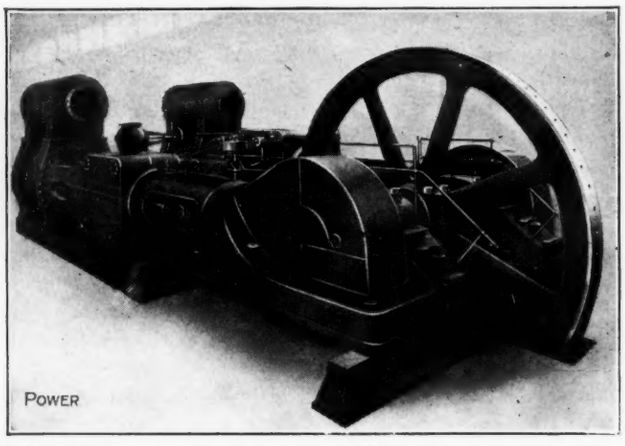
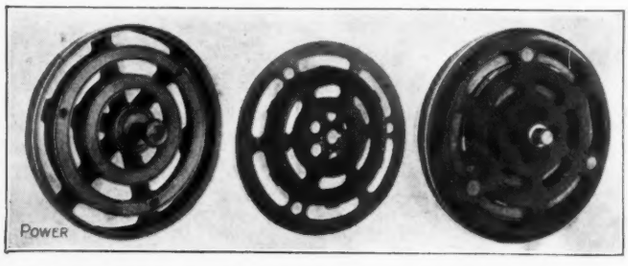


FIG. 1. MESTA 48, 84 AND 84 BY 60-IN. CROSS-COMPOUND BLOWING ENGINE

On Nov. 15, 1913, a contract was signed, the first engine to be loaded for shipment in 90 days and the second engine in 120 days; the contract contained a bonus and penalty clause, as the Woodward Iron Co. were doubtful that the Mesta Machine Co. could make delivery on the dates specified.

There were no engines in stock, as all engines of this size and type are built on special orders only. Work on these engines was started Monday morning, Nov. 17, the time when the order was received at the works.

On Dec. 22, the first engine was completely assembled on the erecting floor. On Dec. 23 at about 6 p.m., the engine was loaded on 16 cars ready for shipment, just 38 days from the time the contract was signed at Woodward, Ala. The engine was thus completed 53 days ahead of the time called for in the contract.



VALVE SEAT VALVE PLATE ASSEMBLED VALVE

FIG. 2

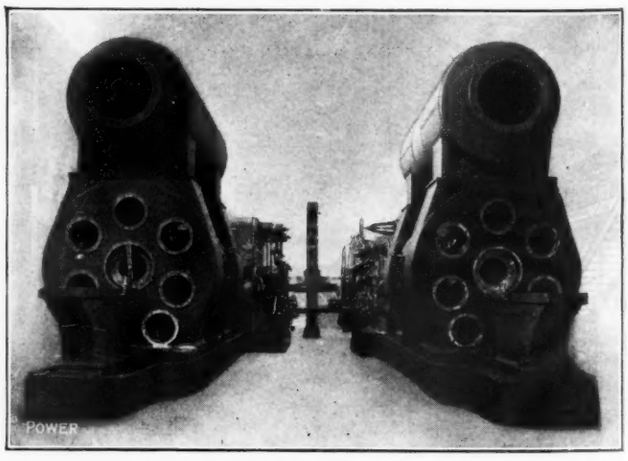


FIG. 3. HOW THE AIR RECEIVERS ARE MOUNTED ABOVE AIR CYLINDERS

Arrangements were made with the Pennsylvania R.R. to run the 16 cars as a special train to Cincinnati and with the L. & N. R.R. to take it through as a special from Cincinnati to Woodward, Ala. The train arrived at Woodward on the morning of Dec. 27, three days from the time it left the Mesta plant. It is believed that this is not

only the world's record in building engines of this size, but in delivering 900,000 lb. of machinery a distance of 834 miles in three days.

The second engine was completed on the erecting floor Jan. 12, 1914. It was loaded on the cars which left the plant Jan. 13, just 59 days from the date of signing the contract and was less than half the time called for in the contract, namely, 120 days. It was delivered at Woodward in just 57 hours after shipment.

The magnitude of the task is better realized by a statement showing the work handled. The engines weighed 1,800,000 lb., and contain 10,210 pieces. The lightest piece weighs ¼ oz., the heaviest piece 94,550 lb.

Description of the Engines

The engines are built with the air cylinders placed back of the steam cylinders, Fig. 2. Both the high- and low-pressure steam cylinders are equipped with Corliss valve-gears and the air end with Mesta automatic inlet and outlet valves; they require no valve-gear. A large receiver is placed over each air cylinder, which practically eliminates vibration in the air lines to the furnace. Fig. 3, a rear-end view of one of the engines on the erecting floor, shows the massive but simple construction of the air end of the blowing engines. The engines are designed for 30 lb. of air pressure and to run at a speed of 80 r.p.m.

Right to Water of Streams

By A. L. H. Street

The legal right of an owner of land bordering a stream to use water from it in generating power for mechanical or manufacturing purposes, by developing water power on the stream, has been defined by the appellate courts of the country. These decisions establish the following principal limitations upon the right: The use must be reasonable, and whether there is a reasonable use in a particular instance depends upon the volume of the stream and the needs of other land owners whose property adjoins. The right of owners to use the waters for domestic purposes is superior to that of other owners to use them to develop power. Water not necessarily consumed in mechanical use must be returned to the stream for the benefit of lower owners.

What is here said will be understood as applying to cases where the principles stated are not controlled by a special grant of water privileges, by the acquisition of rights by the long-continued adverse user, or by the law applicable to appropriation of water flowing through public lands.

Under the principle that the right to use a stream in generating power must depend, partly, upon the needs of other riparian owners, it has been held that the right to make such use in operating a mill is not to be measured merely by the amount of grain which the owner may have to grind. (Clark vs. Rockland Water Power Co., 52 *Maine Supreme Judicial Court Reports* 68.) The right of a company to utilize the Niagara River for manufacturing purposes was declared by the New York courts in the case of People vs. Smith (75 *New York Supplement* 1100.) Their decision grants the right to divert waters for that purpose, on condition that unconsumed water be returned to the river, but the New York Court of Appeals has denied the right of a riparian owner to sell a water supply to the prejudice of lower owners. (73 *Northeastern Reporter* 566.)

An Interesting California Decision

In sustaining the right of a company which owned land along a stream to use water therefrom to operate an electric power plant, the California Supreme Court said, in the case of the Mentone Irrigation Co. vs. the Redlands Electric Light & Power Co., (100 *Pacific Reporter* 1082): "The plaintiff makes the novel proposition that the use of the water to generate electric power by a power house on riparian land is not a use within the scope of the riparian rights which attach to the land, unless the electric power is not only generated upon that land but is, also, applied and used within its confines. There is no merit in this proposition. The riparian owner, by reason of the situation of his land, has the right to make any use beneficial to himself on the riparian land which his situation enables him to make, except that, if his use involves a consumption of the water, he may not use more than his reasonable share as compared with other owners, and that he must not pollute the water to the injury of others entitled to it, and that the water he does not consume must be returned before it passes his land. . . . The theory of the plaintiff on this point would seem to come to this: That in the process the water is in some way transformed into electricity, and in that form is carried away and used on nonriparian land. . . . But no such thing occurs. The water is not changed into electricity, nor carried away by the process. . . . It is the force of gravity which turns the wheels, and, being converted into electric power, is carried away on the wires, the water itself being turned back into the stream, as is the case of its use to turn an ordinary mill wheel."

The right to divert the water through an artificial channel on the company's lands was recognized in this case, the same as in the New York case mentioned, subject to the duty to avoid unduly impairing its use by other owners interested.

Right Subordinate to Domestic Use

"The right to the use of water for domestic purposes is primary, and the right to its use as a mechanical power is secondary; and to the extent that the two rights conflict, its use as a mechanical power must be surrendered. Water for use as power should receive reasonable protection. Water for domestic use, and by which the health and cleanliness of the people, and protection against fires are to be secured, is, also, important." (Maine Supreme Judicial Court, City of Auburn vs. Union Water Power Co., 38 *Atlantic Reporter* 561.) If a stream has so small a volume that it does not furnish more water than is required for domestic use by the owners of land bordering the stream, none of them can consume this water to create mechanical power. If the water is not used for domestic purposes, no owner can use it all for manufacturing purposes, to the exclusion of others who may desire to make a similar use. In such a case the water is to be equitably divided, according to the requirements of the several parties.

Largest Keeler Boiler Ever Built

The Nichols Copper Co., Long Island City, N. Y., has the distinction of operating the largest Keeler water-tube boiler ever built. The boiler is set above the new reverberatory furnace, as in Fig. 1. The temperataure of the furnace gases going to the boiler is approximately 1500 deg. The firebox of the boiler is connected to the reverberatory furnaces by a duct entering at the bottom of the boiler furnace and is the width of the boiler. The inside wall of the hot-gas duct extends above the furnace bottom to form a bridge-wall, Fig. 2.

In Fig. 1, is shown the method of connecting the 10-ft. smoke flue at the rear end of the boiler. The breaching rests on the brick work and forms a saddle for the flue, which drops at the rear end of the boiler setting and connects with the chimney. Fig. 3 gives an idea of the construction of the riveted smoke flue, and of the damper arrangement, the damper being operated by hand, by a chain from the deck below by the attendant.

The boiler is of 1280 hp. capacity, contains 12,780 sq.ft. of heating surface, and is designed to carry 220 lb. pressure. There are three steam drums, each 48 in. in diameter, and 23 ft. 9 in. long. The 578 four-inch seamless tubes are 20 ft. long, and are made of No. 9 gage steel. The drum shells are $\frac{9}{16}$ in. thick, with triple-riveted, butt-strap joints, and are fitted with heads $\frac{5}{8}$ in. thick. A 5-in. safety valve is attached to each drum, which has an 8-in. steam outlet. The boiler complete weighs 200,600 lb.

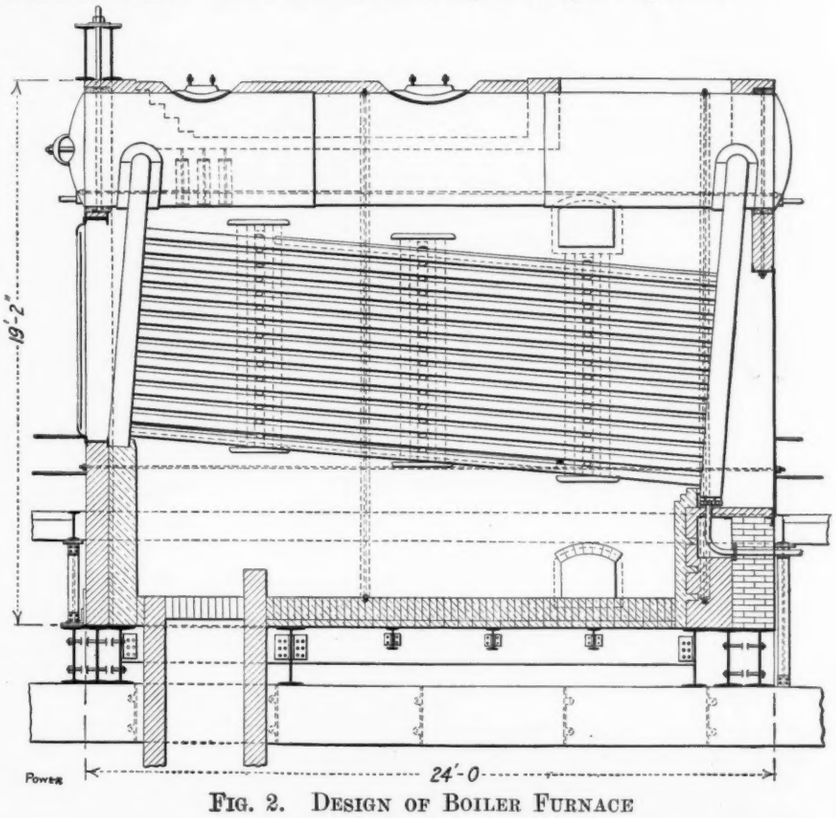


FIG. 2. DESIGN OF BOILER FURNACE

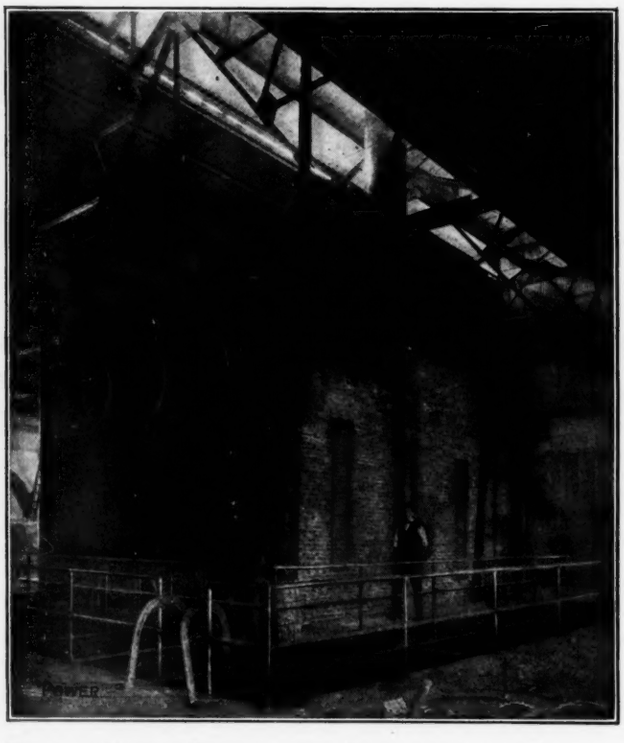


FIG. 1. BOILER SETTING OVER REVERBERATORY FURNACE

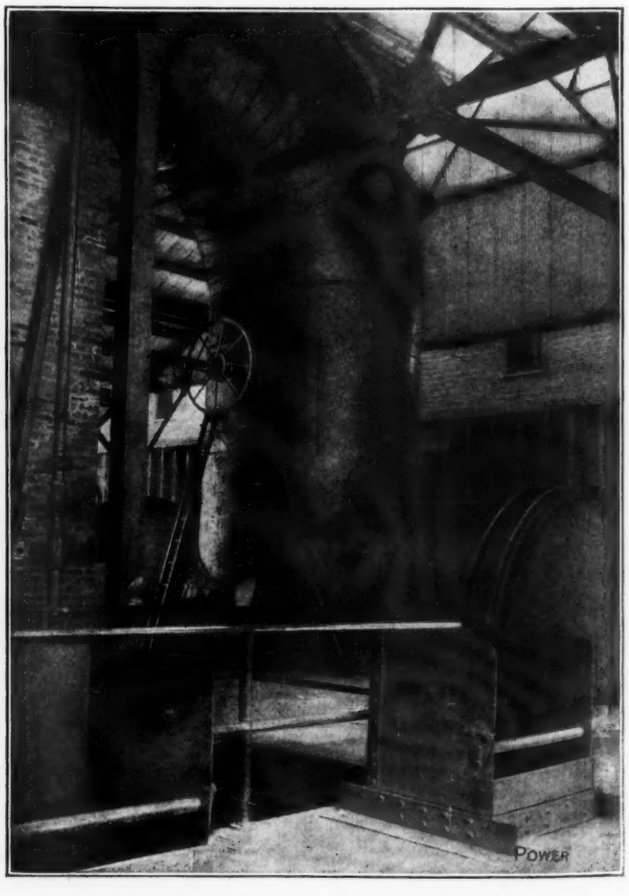


FIG. 3. CONSTRUCTION OF THE 10-FT. SMOKE FLUE

Turbine-Driven Rotary Compressors

By Dr. Alfred Gradenwitz

A short time ago, a remarkable turbo-compressor was completed at the Allgemeine Elektricitäts Gesellschaft turbine factory, which is capable of delivering the enormous quantity of 3,531,400 cu.ft. of free air per hour at a pressure of 140-170 lb. per sq.in. This output corresponds to a power input of 12,000-13,000 b.hp.

This is one of three compressors of the same output to be supplied to the Victoria Falls & Transvaal Power Co. This company was the first to avail itself of the advantages afforded by large-size turbo-compressors and to adopt the transmission of power in the form of compressed air on a large scale. The company already has twelve 4000-hp. turbo-compressors in commission in its power stations, situated close to Johannesburg. The compressed air generated by these machines is transmitted through a pipe line 18.6 miles in length and supplies 17 mines, for operating rock drills and other compressed-air tools. The installation of the three new compressors will raise the total amount of energy transmitted in the form of compressed air to 84,000 hp.

Fig. 1 shows the general arrangement of the compressor referred to in the foregoing. On the left-hand side is the steam turbine, designed for high-pressure, superheated steam, and fitted with automatic nozzle regulation. This is the first turbine built to give an output of 12,000 hp. at a speed of 3000 r.p.m.

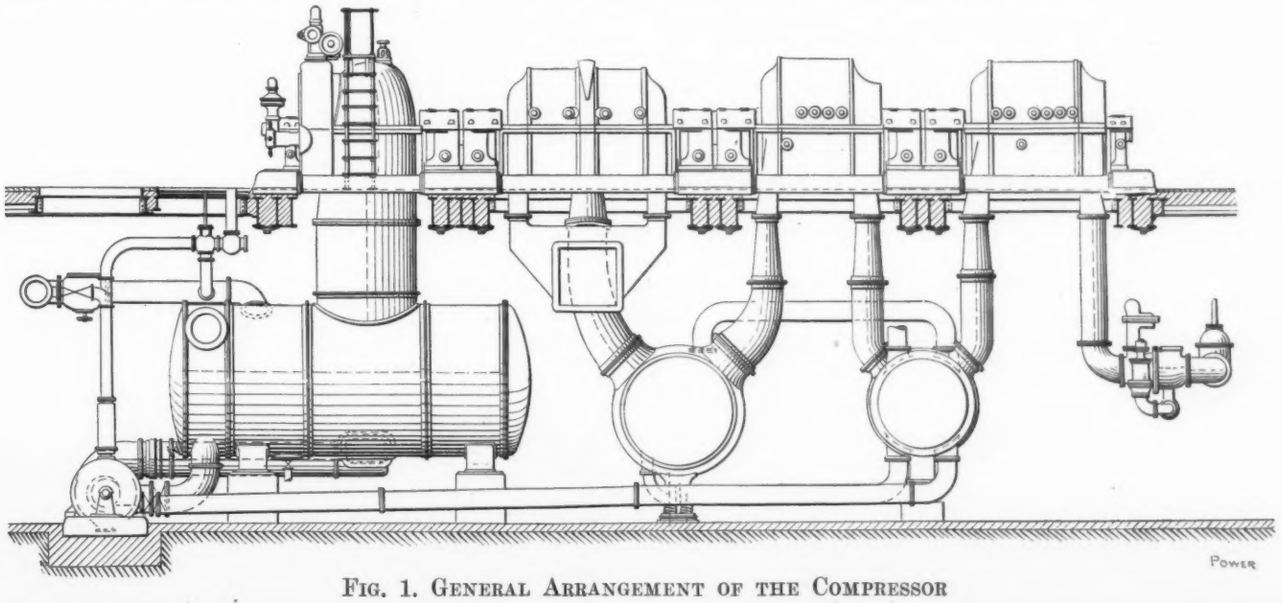


Fig. 1. General Arrangement of the Compressor

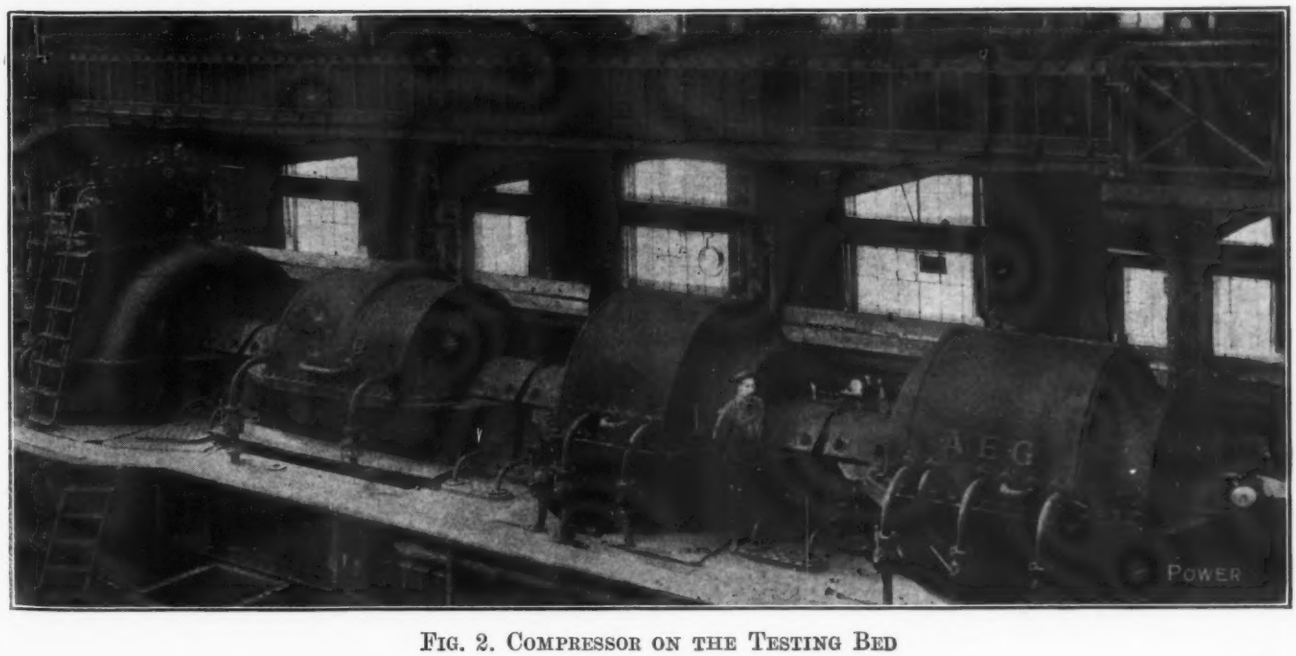


Fig. 2. Compressor on the Testing Bed

The compressor, consisting of three cylinders, is connected to the steam turbine by a flexible coupling. The low-pressure air cylinder is next to the turbine, and in view of the large quantity of air handled, is designed to draw in air on both sides. The air passes from the main suction pipe, the square section of which is visible in Figs. 1 and 2, into the two ends of the low-pressure compressor, passing out to the intermediate cooler, slightly compressed at a temperature of about 100 deg. C., in which it is cooled to about 30 deg. C.

The intermediate cylinder, through which the air next passes, is constructed with an intake on one side only, as the volume of air has been so reduced that it is no longer necessary to divide the air current on account of the section of the impellers. The air compression is further increased in this cylinder, and the air passes out of it in a highly heated condition, to be cooled again in a second cooler, Fig. 1, whereupon it enters the high-pressure cylinder for final compression and is then discharged to the pipe line through the pressure pipe shown in Fig. 1 on the right.

As the cooling effect in the intermediate coolers is not sufficient to permit the process of compression to be carried out economically, the compressor cylinders themselves are water cooled. The pipe lines through which this water is brought is shown in Fig. 2, which is a view of the compressor on the test bed.

The light foundations upon which the turbo-compressor is erected are especially noteworthy. They permit the intermediate coolers with their piping and the condenser plant for the turbine to be installed conveniently below them in the basement.

This first 12,000-hp. compressor, on test, satisfied the guarantee conditions for steam consumption, which were more severe than would have been thought possible for units of 1000 to 2000 hp. The units ran on the test bed for several hours with a load up to 12,000 hp., corresponding to normal working conditions.

Nonpareil Insulating Brick

This type of brick is used to back up firebrick where the retention of heat is desirable, and not as a substitute for firebrick. It is composed of diatomaceous earth, minute skeleton shell plants, of almost pure silica, finely ground cork and clay. When the brick is fired the cork is first carbonized and then gradually burned out, which leaves the brick porous. Each brick is 9 and 4 by 2½ in. in size. It is suitable for use in boiler settings, gas producers, or in the construction of any type of heating furnace, ovens or kilns, etc. A brick weighs but 1½ lb. but will readily withstand a crushing strain of 140 lb. per sq.in.

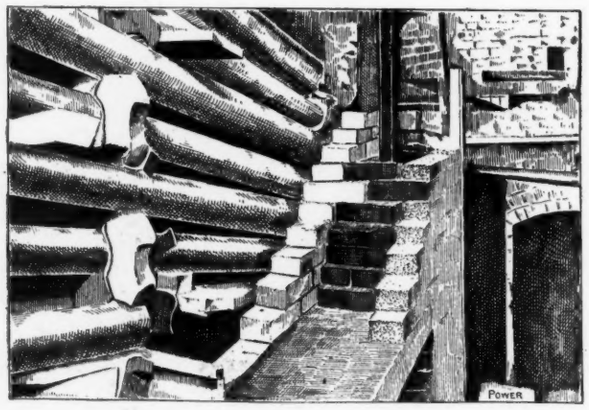


FIG. 1. NONPAREIL BRICK AS USED IN A BOILER FURNACE

The bricks are laid in a special insulating cement, requiring 400 lb. per 1000 bricks. They may be laid in several ways, outside of the firebrick and the common brick of a boiler setting, Fig. 1. When placed outside the common brick, the exposed surface may be finished off with a coat of cement plaster, Fig. 2. In any case, an inner lining of firebrick must be used, for the insulating brick is not a refractory material and will not withstand the abrasion to which firebrick are subjected.

To hold the courses of different brick together, metal ties extending through the common brick to the firebrick can be utilized, as in Fig. 3, or the brick can be tied together in the ordinary manner. The two, however, make a serviceable setting.

These bricks, made by the Armstrong Cork Co., Pittsburgh, Penn., require six to the square foot for a 4-in. wall. They are shipped in crates holding 88 bricks or in any increased quantity.

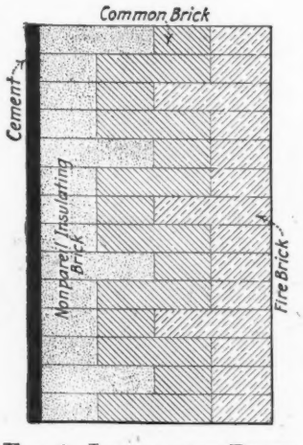


FIG. 2. INSULATING BRICK AND CEMENT COATING

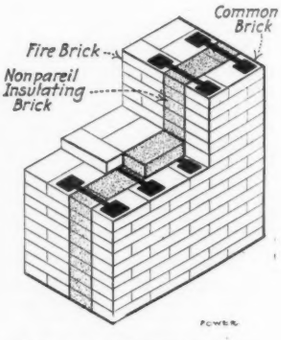


FIG. 3. METHOD EMPLOYED IN TYING COURSES OF BRICK

Providence Hotel to Operate a Plant—The Narragansett Hotel, in Providence, R. I., has, after a long contest between the isolated and central-station advocates, decided to put in a plant of its own. Even when the isolated plant was handicapped with a fixed charge of 16 per cent. and a steam rate of 29 lb. per indicated horsepower-hour, the resulting average cost per year was under two cents per kilowatt-hour at the switchboard. They are now paying about three times that rate to the electric company, the load being mostly lighting. Two Ideal Corliss-valve engines will be used, guaranteed to produce an indicated-horsepower-hour under 25 lb. As the boilers were already installed, and as the hotel has considerable use for exhaust steam, the additional cost for light and power should be very low.

Testing Arc-Light Circuits

By James Brakes, Jr.

SYNOPSIS—Directions for testing for breaks and grounds on arc-light circuits by means of a magneto and bell.

Since street arc-lighting circuits are generally long, considerably exposed and of comparatively small wire, they always give more or less trouble on account of grounds, breaks and crosses.

Grounds are most likely to occur around the fronts of stores where wires are run in proximity to iron awning frames or fittings. Also, where the lines run through trees, there will always be more or less of a ground, especially in wet weather. In this case, however, the trouble would be more correctly termed a leak, as it is due to defective insulation and does not constitute a direct connection to the ground, as would happen, for example, if one of the lines came in contact with an iron pole or a gas or water pipe.

All arc lines should be tested at intervals during the

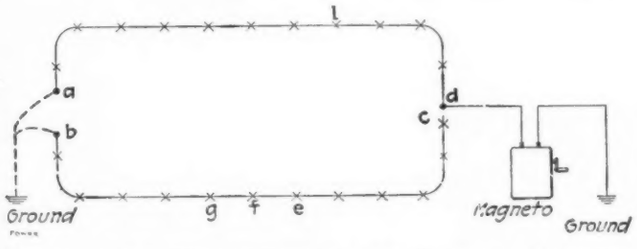


Fig. 1. Locating Break by Means of a Magneto

day to see if any faults have developed, so that they can be looked up and remedied, if possible, before it is time to start up in the evening. This may be done in various ways, but in many cases grounds and breaks are located by the use of an ordinary magneto bell. This is able to ring through a long length of line, and is easily carried around from place to place.

Locating Breaks

Series arc circuits should be tested frequently for breaks by connecting a magneto to the terminals of the circuit at the station, and ringing through it. If the bell fails to ring, it shows that the circuit is broken somewhere and the break should be looked up at once. If the circuit is arranged in loops that can be cut out by means of switches on the poles, the first thing to be done is to cut out the loops in succession until a ring is obtained. This will show in which loop the break is, and the fault can then be further located, but in many cases it may be found by a simple inspection. In general, however, the problem will be to locate a break on a simple series circuit, such as that represented in Fig. 1.

Assume that it is found by ringing up between *ab* and the station terminals, that there is a break in the circuit. First connect *a* and *b* together and ground them, as shown by the dotted lines. Then go to point *c* as near the middle of the circuit as possible, and open the circuit by lowering a lamp and removing the wires, or in any other way that may be convenient. Ground one terminal of the testing magneto, by connecting it with a hydrant or other ground connection, and attach the other terminal to one end of the circuit *d*. Ring through, and if the bell rings, it shows that the part of the circuit from *d* around to the station is all right and that the break is in the other half.

Now close the circuit at *c* and move on to *f*, about halfway between *c* and the station. The circuit is now opened

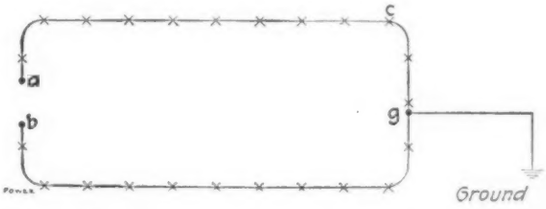


Fig. 2. Illustrating Ground in Arc-Lighting Circuit

and the magneto connected as before. If a ring is obtained when the bell is connected to the left-hand end of the line, it shows that the stretch of circuit *fgb* is intact; while, if the bell does not ring when connected to the right-hand side, it shows that the break is between *f* and *c*, as at *e*, because the previous test showed that the part *dla* was all right. In this way, by making a few tests, the stretch of a circuit in which the break occurs can be located within narrow limits, and the break itself can then usually be found by a careful inspection.

When a line becomes grounded at any point *g*, as indicated in Fig. 2, the ground may be located by using a magneto, in which case the ends of the line *ab* at the station are left open, instead of being grounded as when testing for breaks. The line is then opened at *c* near the

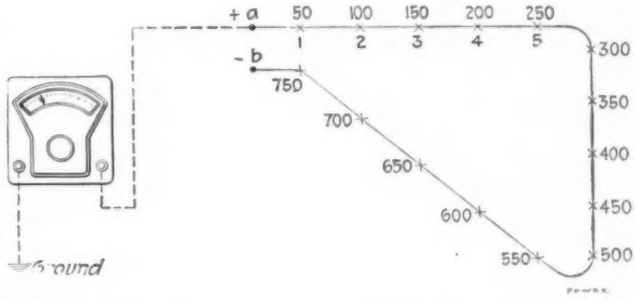


Fig. 3. Locating Ground by Means of Voltmeter

middle point and each side is rung up, one terminal of the magneto being connected to the ground. The side on which a ring is obtained is the one on which the ground exists. The half on which the ground is located is then opened at its middle point, and in this way the part of the line that is grounded is soon located within narrow limits.

Locating Grounds by Means of a Voltmeter

If a high-reading voltmeter is available, it can be used for locating grounds on an arc circuit as indicated in Fig. 3.

In this case, there are, say, 15 lamps operated on the circuit. Let the total pressure generated by the dynamo be $15 \times 50 = 750$ volts, allowing 50 volts per lamp (including its proportion of the line drop). The difference of potential between the negative side of lamp No. 1, and *a* is 50 volts. Between the negative side of No. 2 and *a*, 100 volts, and so on, as indicated. If one terminal of the voltmeter is connected to *a* and the other to ground, a reading will indicate a ground on the line.

Suppose, for example, that there is a ground on the line at *g'*; the voltmeter will then be connected across four lamps, and will give a reading of about 200 volts. The voltmeter reading, therefore, indicates how far the ground is out on the line. If a reading of about 100 volts is obtained, it is known that the ground is somewhere between the second and third lamps.

Calculating Pressures and Temperatures in Diesel Engines

By C. R. Courtenay

SYNOPSIS—By means of the chart, the temperature corresponding to any given compression pressure may be found; also the necessary clearance volume to produce this pressure and temperature.

Some time ago, the writer was called upon to assist in the design of a 75-hp. Diesel engine, together with a two-stage air compressor, which was to furnish air at 1000 lb. for fuel injection. Accordingly, a set of compression and temperature curves were laid down, that would serve as a handy reference in present and future calculations. Since the curves were got out, many occasions have arisen for their use in connection with gas-engine, oil-engine and compressor work, and they have saved much repetition of calculations. They cover a range of compression from atmospheric pressure to 1000 lb. absolute, and for varying conditions from adiabatic to isothermal.

The bottom scale represents volumes, while at the left the absolute pressures are shown both in pounds per square inch and in atmospheres. At the top are divisions representing temperatures (Fahrenheit). It will be unnecessary to use these divisions, however, as the temperatures are all carried out at the right of the curves and can be read directly.

Corresponding to each compression curve, are two temperature curves—one for 32 deg. initial temperature, and the other for 60 deg. initial temperature.

It will also be noticed that there are four compression (volume) curves giving a range, as stated, from adiabatic to isothermal. In laying down these curves, it was thought best to cover the two extreme conditions and then lay down between them the two curves 1.3 and 1.35, which would cover the conditions to be expected in actual practice. The numbers 1.30 and 1.35 represent the exponents of the *PV* curve under these intermediate conditions and 1.41 that with adiabatic compression. Curve 1.35 would represent the conditions with fair cooling of the cylinder, while curve 1.3 would represent conditions under still better cooling.

An example will best show how to use the chart. Suppose it is desired to know the volume and temperature at the end of the compression stroke in a Diesel engine, assuming that air is taken in at 32 deg. F., and that the compression pressure is 550 lb. absolute. Assume that the cooling is fair, hence choose the curve marked 1.35.

Following up the left-hand column, we come to 550 lb. Now pass to the right, as shown by the broken lines, until the 1.35-32 deg. heat curve is reached. Follow vertically from this point to the top scale, where we will find a corresponding temperature of 797 deg. or we can pass horizontally to the 1.35 column and find 797 deg.

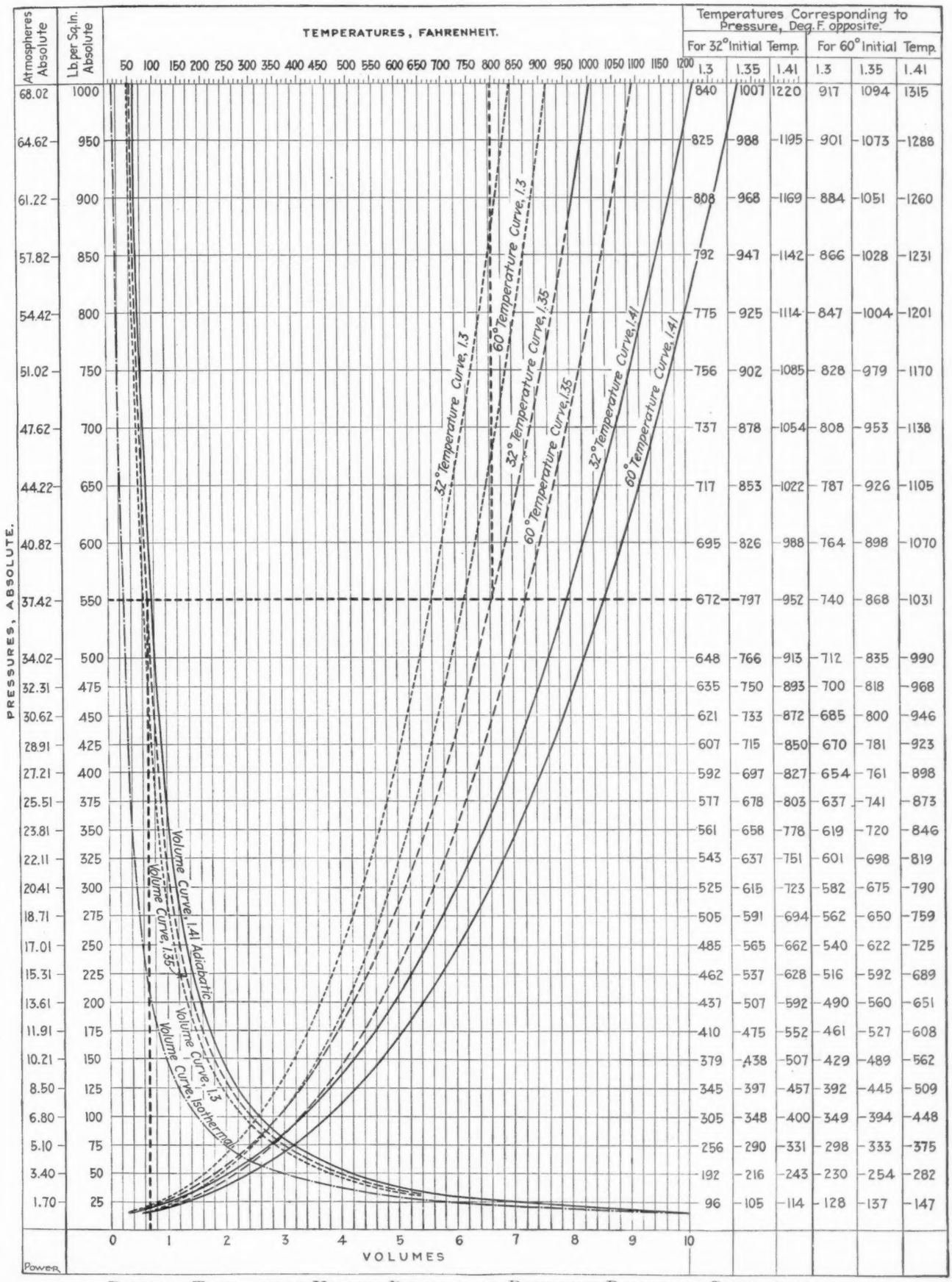
To find the corresponding volume, start at 550 lb. again and pass along the horizontal line to the right to the 1.35 compression curve. Directly below and on the base line is found 0.069, which means that the quantity of air taken into the cylinder has been compressed into a space 0.069, or 6.9 per cent. of its original volume. From this volume, one is enabled to calculate the necessary clearance space in the engine cylinder.

It might be mentioned that in practice this clearance volume is usually made somewhat less than the table shows, as the volumetric efficiency never reaches 100 per cent.

In the foregoing example, if the initial air temperature had been 60 deg. F., instead of 32 deg. F., it would have been necessary to pass along the horizontal line from 550 lb. to the column headed 1.35 and 60 deg. initial temperature and the result would have been 868 deg. or a rise of 71 deg. for a difference of 30 deg. in the intake temperature.

The question has already been raised by Mr. Wentworth, in Power, of raising the initial temperature of the air in the Diesel engine and thereby lowering the compression pressure. In the first example mentioned, the compression was 550 lb. absolute, the intake 32 deg. and the final temperature 797 deg. Suppose that this temperature is sufficient for complete combustion in a Diesel engine cylinder. Assume that air is taken into the cylinder at 60 deg. instead of 32 deg. and see what compression is necessary to produce this temperature. First, look under the column marked 60 deg. initial temperature and 1.35, and we will find 800 deg., which is near enough to 797 deg. for practical purposes. Now, follow the horizontal line from 800 deg. to the left and we find 450 lb. absolute, the compression pressure necessary to produce this temperature. This shows that the compression has dropped from 550 to 450 lb., with practically the same final temperature.

The above example shows that Mr. Wentworth's theory is not without foundation. It should be mentioned, however, that by raising the temperature of the intake air, the weight which can be taken into the cylinder is decreased. This is so because the volume of air so heated is increased, and this increase is in direct proportion to the absolute temperatures. In other words, the volumetric efficiency is decreased.



PRESSURE-TEMPERATURE-VOLUME DIAGRAM FOR DIFFERENT DEGREES OF COMPRESSION

Double-Cushion Quick-Closing Trip Valve

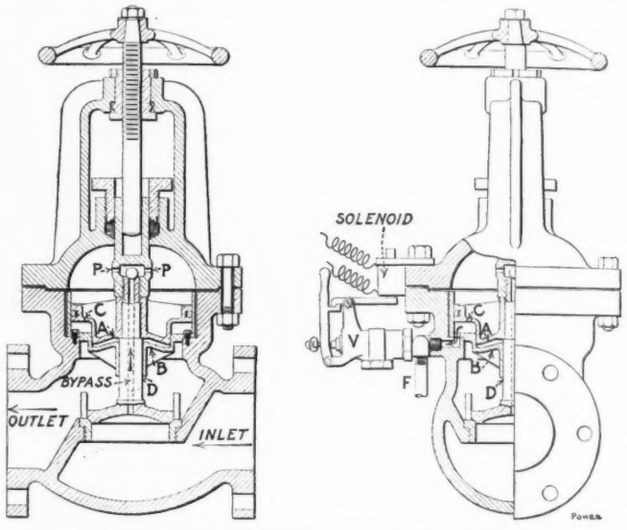
An electrically operated emergency trip valve is illustrated herewith. It is intended as an emergency shutoff or engine stop valve, that may also be operated by hand, or by an electrical solenoid and push button from any part of the plant. This valve is built by the Golden-Anderson Valve Specialty Co., 1217 Fulton Building, Pittsburgh, Penn.

The sectional view shows the Corliss double-dashpot method of cushioning the valve disk, the dashpot occupying the upper part of the valve body. This feature insures a cushion in the opening and closing of the valve disks, and brings them in alignment with the seats when closing, regardless of the position of the valve. The inside dashpot is shown at *A*, attached to the valve spindle D. The outside bronze dashpot *B* acts as a cylinder and is held in place by cap bolts.

A bypass is made through the valve stem from the under side of the valve disk, which is under boiler pressure, to the upper side of the dashpot *A*, through the ports *PP*. A port at *C* also admits steam at boiler pressure, which balances the dashpot *A*.

As may be seen in the semi-sectional view of the valve, an exhaust port communicates with the space between the two dashpots and leads to the pilot valve *V*.

When the pilot valve is tripped the steam pressure between the two dashpots escapes through the drip pipe *F* and allows the valve to close, thus shutting off the flow of steam through the valve. When this occurs the double-cushion feature gives an instantaneous drop to within 1/8-in. of the seat, and then closes easily under the control of the secondary dashpot. By turning the handwheel, the stem may be screwed onto the top of the valve stem, thus making a steam-tight joint and causing a permanent closure of the valve. The valve *V* is controlled by an electric solenoid connected to either direct or alternating current for continuous or intermittent service.



SECTIONS OF THE EMERGENCY TRIP VALVE

Practical Refrigeration-Plant Suggestions

BY WILLIAM S. LUCKENBACH

SYNOPSIS—Impurities in the feed water may carry over with the steam in a distilled-water ice plant and seriously affect the ice. A bypass from the weak-liquor pipe to the ammonia pump may be used to relieve the gas in the pump. Condenser coils exposed to the sun's heat should be shaded; the covering also creates a draft between the coils. Thermometers in the liquor anhydrous pipe near the receiver, in the weak-liquor pipe near the absorber, and in the water line, if an ice plant, are as important as the brine thermometer. Suggestions on cleaning equipment.

The season is at hand when every owner and engineer dealing with ice-making and refrigerating plants should endeavor to improve on last season's output without expensive alterations.

A surface blowoff should be used when ice is made from distilled water. A heater and purifier to heat the water to not less than 210 deg. F. should be used, when ice making is the object, because at that temperature the larger portion of the impurities in the water will be precipitated before leaving the heater. The less impurities forced into the boiler the less there is to blow out, or form scale; the less the blowoff is used the less hot water goes to the sewer, less fuel is wasted and there is less work for the fireman. A high- and low-water alarm is an advantage, especially the high alarm, where distilled water is used for making ice, for if the water in the boiler should get too high the steam might carry some impurities with it, and should the filter not be capable of cleaning properly the foreign matter would pass into the cans and possibly 48 hr. later one would find bad ice without being able to account for it. A water-level alarm tends to make the fireman more particular about the water level.

PUMPS

See that the clearance of all ammonia pumps is small to prevent the pump getting gas bound. To quickly remedy trouble of this kind have a permanent bypass of, say, 1-in. pipe from the weak-liquor pipe to the pump suction with a valve connected in the lines. If gas accumulates in the pump, open this valve and allow the weak liquor to enter the pump and absorb the accumu-

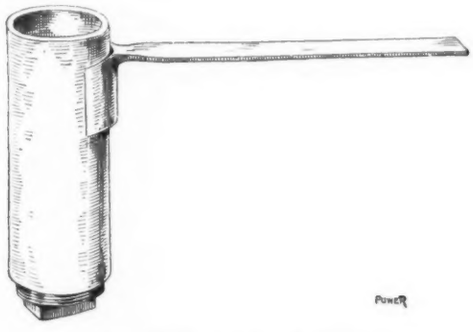
lated gas, after which close the valve and run as usual.

Should the water supply be from a river or well, be sure the check valve on the end of the suction is working rightly, and that it will not fail during the busy season when tons of ice may be quickly lost. Do not stand on the bank of the river or top of the well and guess it will last another season, but hitch a chain block to it and get the valve out and examine it. One will have plenty to worry about during the season without courting a job like this.

In case of an absorption machine, the generator coils or tubes should be cleaned, as there is frequently some impurity in the aqua ammonia which adheres to the pipes and forms a nonconductor of heat, especially is this necessary where low-pressure or exhaust steam is used in the generator. Supply the generator with strong aqua ammonia, because the stronger it is the less heat is required to liberate gas, and as there will be less heat in the gas when reaching the condenser there will be less cooling water needed.

Condenser and Weak-Liquor Coils

The condensing coils for both the weak liquor and liquid anhydrous, whether of the ordinary atmospheric or double-pipe type, should be ample to allow both liquors to leave the coils at or near the temperature of the cooling water. To save cooling water have the coils in the open and get the benefit of a breeze from any quarter. It is common to see condensing coils on the roof without protection of any kind from the heat of the sun. A simple canvass covering would not only reduce the heat, but create a draft through the coils and help lower the temperature of the cooling water by evaporation.



Receptacle for Testing

The weak-liquor pipe leading from the cooling coils to the absorber, and the liquid anhydrous pipe leading to the receiver or expansion valve, should be run through the coolest part of the building to maintain a temperature approximately the same as that at the condenser outlet. If this cannot be done, it would pay to cover the pipes to protect them from the warm surrounding atmosphere.

Referring to the standard table of properties of saturated ammonia, we find that 1 cu.ft. of liquid ammonia at, say, 85 deg. (167.4 lb. pressure) weighs 37.10 lb., and 1 cu.ft. of gas weighs 0.5595 lb. Therefore, a cubic foot of liquid at 85 deg. F. expands 37.10 ÷ 0.5595 = 66.3 times. Liquid anhydrous at 65 deg. F. (118.1 lb. pressure) weighs 38.09 lb., while a cubic foot of vaporized ammonia at this temperature weighs 0.3996 lb., and the volume of gas will be 38.09 ÷ 0.3996 = 95.2 times that of the liquid. The ammonia at 85 — 65 = 20 deg. lower temperature expands 28.9 additional times and extracts a proportionately greater amount of heat from the brine.

Thermometers

The more general use of thermometers in ice plants regardless of the kind of system, but especially in the absorption plant, should be advocated. There should be one on the feed pipe between the feed pump and steam boiler. When the heater becomes dirty and the absorption of heat is slower, the thermometer will indicate the condition. Thermometers in the weak-liquor pipe near the absorber and in the liquid anhydrous pipe near the receiver or expansion valve assist greatly in getting economical results from the plant. Suppose the normal temperature of the liquid ammonia at the expansion valve was 70 deg. F., and that of the brine 10 deg. F. The engineer in glancing at the thermometer notices a rise in temperature of 7 deg. F. He knows that the gas at the higher temperature will absorb less heat from the brine and result in an increase in the brine temperature. With the thermometer in front of him there is no good reason why the brine temperature should increase several degrees and why he should tramp around and wonder what caused it. He will know at once that there are only two causes, either too little cooling water for the condenser, or that the coils need cleaning, or that it is due to a combination of both. If an ice plant, the water to be frozen needs the same attention. Any rise in its temperature means that a correspondingly greater number of heat units must be extracted by the brine. The practice of feeling the water pipe to determine temperature variations is poor. Not one in 50 can detect a difference of 8 or 10 deg. in temperature. It would be just as sensible to discard the brine thermometer and rely on getting the correct temperature by dipping the hands in the brine. Another matter of importance is to insert near the expansion valve on the high-pressure side, a valve through which liquid anhydrous can be drawn off and tested for its purity. The test is made by using a cup made of 1-in. pipe plugged at one end and with a handle attached. A tube or nipple from the test valve should reach nearly to the bottom of the test cup. Draw a little liquor into the cup. If the ammonia evaporates clean and dry, it may be considered practically pure.

The Absorber

All absorbers operate to produce one result, i.e., to have the expanded gas from the brine tank absorbed by the weak liquid from the generator, to get the original strength of the ammonia. While the liquor will readily absorb the gas, it must be cold enough to absorb the quantity necessary for the liquor to regain its original strength. Therefore, the tubes or coils in the absorber must be clear and clean so that the exchange of heat between the cooling water and weak liquor will be rapid. When the absorber cannot be shut down for long the tubes may be cleaned with water or steam at high pressure. Steam cuts the scum from the coils better than water, but it also raises the temperature of the absorber, but by doing the cleaning when there is a large amount of ice on hand, half of the coils may be cleaned at one time without considerably decreasing the output.

Brine Tank

If the brine tank has not been cleaned for a few seasons it should be cleaned as soon as possible to avoid rusting. Have the coils disconnected top and bottom and blow out each coil separately with steam, followed with air or apply heat to evaporate any water left in the pipe. In freezing weather, finish one coil complete before blowing the next, and give all coils a pressure test. They should stand 300 lb. pressure. In connecting the coils use only the best quality of rubber for flange joints, because many of these joints are difficult to get at when the plant is in operation. Have all nuts run loose on the bolts, and see that the nuts do not jam into the body of the bolt as leaks may follow.

Pipe and Fittings

Use extra-heavy pipe and fittings on the ammonia system. In cutting pipe it frequently happens that the cutters depress the pipe, reduce the area and leave ragged edges on which foreign substances gather. Do not use a nipple or piece of pipe without looking through it for blisters and obstructions, as this precaution may save much trouble later on. In making screwed ammonia joints do not use pasty substance of any kind, as the particles get jammed between the threads and, while the joint may be tight, it will be only a short time when the ammonia will leak through at a time when one has plenty of other urgent matters on hand. The first requisite is a good, clean thread on both pipe and fitting, then dip them in a mixture of lubricating oil and graphite.

How a Municipal Station Was Made to Pay

By Joseph A. Jeckell

SYNOPSIS—The author describes how he reorganized a municipal electric station which was losing money and made it produce current at the lowest cost in England. The plant is now paying over 13 per cent. on the capital invested and selling current at an average rate of 2.12 cents per kilowatt-hour.

In 1901 the writer took hold, as manager and engineer, of the electricity works, a municipal undertaking, in the city of Coventry, England, having a population of 110,000.

This undertaking had been in operation six years and each year there was a loss after the capital charges had been paid, as in Britain the interest and sinking fund on the capital have to be met year by year and if not provided by the undertaking have to be put on the local taxes.

In 1901 the plant consisted of four Lancashire boilers, four compound jet condensing engines, driving by ropes; four single alternators, 87 cycles, 2000 volts generated, 200 volts distributed from substations. Capacity of plant, 550 kw.

The station was situated on a canal whence the condensing water was drawn.

Coal, 11,000 B.t.u., cost $2 per long ton. All mains were concentric and laid underground.

The gas works were also owned by the municipality and were a very flourishing concern, especially as nearly all the works in the city were driven by gas engines supplied by gas from the municipal works at 40c. per thousand.

The powerful gas committee, perhaps naturally, placed every possible difficulty in the way of pushing electricity sales, and as the gas undertaking was the "Old Love," the council took the same view and would not even allow the writer a salesman, so not to be beaten, he added these duties to those of manager and engineer and did the selling himself.

On taking hold the writer determined at once to change the whole system to two-phase, 50 cycles. Two-phase was chosen as thereby the single-phase mains could be utilized. Lighting was supplied single-phase and motors two-phase.

This necessitated scrapping the engines and alternators and a large proportion of the transformers and meters. It would have been more advantageous to have at once scrapped the boiler-house plant as well, but the committee would not hear of this. Britishers are not good scrappers. Moreover, owing to the timidity of the council, the work was only allowed to be done piecemeal and each addition had to be shown to have paid before the next one was sanctioned, thus delaying by several years the results eventually attained.

The writer decided upon the same kind of steam plant as he had installed at South Shields, where he had previously designed and erected the plant. This plant was triple-expansion, slow-speed, open-type vertical marine engines, surface condensing, direct coupled to the alternator and exciter. The air pumps and circulating pumps were driven from the intermediate crosshead, thus doing away with auxiliaries which are so frequently costly in steam consumption and upkeep. The cylinders were steam-jacketed.

In many stations there are found quite a number of different-sized engines and in not a few, different types of engines. In fact, some stations look like museums more than works for the efficient production of power.

The writer arranged to have all the engines the same type and same size. But as they would have to work on light loads as well as heavy, he looked for an engine which had a large range of economy and the above type was found to most nearly approximate his requirements. He specified that the steam consumption should be taken at ½ to ¾ and full loads and gave a bonus for each and every pound under the specified amount as the average of these three loads, but before deciding on this type he exhaustively tested the engines at various loads on the brake at the maker's works. He was the first engineer in Britain to install this type of engine for generating electricity.

Surface condensing was chosen as leaks can be so much better detected than when jet condensing is used.

The condensed water after having the grease extracted by chemical means was returned to the boilers.

A water softener was used to provide make-up feed, so that nothing but absolutely pure water was used, which is so essential if the best service is to be obtained from the boilers, especially with water-tube ones.

The coal obtainable was carefully tested and that which contained most heat per dollar was chosen. Grates and stokers were installed on the boilers suitable for this particular kind of coal. The writer found that by installing the grate and stoker most suitable he obtained an increased capacity of 17 per cent., and a decreased cost of evaporation of 54 per cent.

Six sets, 700 kw. each, of this type of plant were installed in the existing building with additional Lancashire boilers as the load required.

Afterward the writer designed a new station, 20,000 kw., with water-tube boilers, superheat, overhead bunkers, coal-conveying plant, etc., with 3000-kw. turbines, which was erected in sections as the demand for power increased.

The sales were pushed as much as possible, but due to the action of the gas committee in maintaining incandescent-gas mantles at a nominal price not so much progress was made in the direction of lighting as might have been expected. The force was, therefore, concentrated on the supply of power. Motors were kept in stock and loaned out with a fair purchase clause so that as soon as the customer was satisfied he was in a position to purchase his motor.

Slip-ring motors were used where the demand was small, but where it was considerable, a substation was built on the consumer's premises and he was supplied with squirrel-cage motors. Where possible, motors were installed with 2000 volts on the stator, thus doing away with the cost of transformers and the loss in them when the motors were idle.

Ordinary house wiring was not carried out by the electricity department, this being left to the contractors who were thereby induced to canvas for customers to the mains. The department, however, did the wiring for the motors as at first the contractors were not skilled in this work.

A special system of wiring, designed by the writer, was used whereby the cost of wiring was reduced one-third. This system was also passed by the Board of Trade for wiring to the motors.

Two single-phase meters were installed to each motor, thus only single-phase meters were stocked. This enabled a motor whose phases were not evenly balanced to be at once detected and it was replaced before a complaint was received. The writer considered that a satisfied consumer was the best canvasser he could have.

Financial Proposition

This was naturally the most important of all, as it was the crux of the whole situation, the main object being to make the undertaking a financial success, whereas up to 1901 it had been a ghastly failure. The first thing the writer did was to design a ledger which would show at a glance where the costs were too high, the accounts of all other undertakings being at the writer's disposal.

A ledger was designed, containing the Board of Trade headings, amplified as suited the special circumstances of the case. This ledger contained 52 weeks, 12 months, four quarters, two half years and a year, a page being devoted to each. The weeks were carried forward to the months, the months to the quarters, etc. The results for the current period were entered on the right-hand page, the last year's results being posted on the left-hand side, so that on opening the ledger anywhere the results of the current period could at a glance be compared with those of last year. This enabled the writer to keep an absolute check on the expenditure under each heading. The costs were worked out for each item to one five-hundredth of a cent per kilowatt sold.

The consumer's meters were read every three months and the ledger brought out automatically a balance every three months. This method of easy comparison, rendered possible by the ledger, enabled a vast number of economies to be carried out at the works, thus reducing the cost of manufacture considerably as is evidenced by the fact that the total cost, exclusive of capital charges, was $21,790 in 1901 for 341,810 kw.-hr. sold; and in 1904, was only $22,420 for 920,192 kw.-hr. sold.

As is usual in the British Isles, part of the books were kept at the electricity works and part by the city treasurer. Chartered accountants were called in and recommended that all books be kept by the writer. This method was adopted and thenceforth he kept all the books and prepared the balance sheets, all the accounts being audited by chartered accountants who conducted a continuous audit all the year.

Immediately a surplus was made, the rate payers clamored for a contribution to be made to the local taxes, as they had to raise so much money formerly to make good the deficit on the electricity works; $61,250 had been added to the local taxes to meet the deficit charged to the works. As a "sop to Cerberus," $5000 was paid to the taxes in 1907. This was increased gradually until this year $25,000 was paid over, the total to date being $86,500.

The writer, however, very strongly urged the building up of a large reserve fund, especially in view of the fact that there were a great number of liabilities standing in the books with no liquid asset to represent them. The outstanding debt on all plant scrapped by the writer, not provided by the sinking fund, was found out of revenue. This was sanctioned and the amount already placed to the reserve fund is $300,000.

In order to place the undertaking on an *absolutely* sound basis, the writer examined all the accounts, which had been charged to capital since the undertaking was started, and wrote off all those items not represented by a liquid asset. It was found that these totaled $135,000 Moreover, there was $200,000 worth of plant which might have to be scrapped before the time the loans granted for it were extinguished by the sinking fund, the original life allowed being too long, hence the extreme desirability of building up a reserve fund as rapidly as possible which could be used for this purpose.

The life of all parts of the plant was estimated, with the years run and the years to run, and it was found that at the then rate, the sinking fund would extinguish the loans many years before they would be liquidated by ordinary depreciation, though in the earlier years considerable sums might be required as aforesaid. This report received the unqualified approval of the special financial electrical expert of the British government. Doubtless

the fact that the writer acted as manager, engineer, salesman and accountant worked for simplification and efficiency and by his methods of organization he found no difficulty in keeping in close touch with, and control of every detail from the calorific value of the coal to the balance sheet. His watchword was efficiency, brought about by organization, simplification and standardization.

The Board of Trade returns are given herewith. All electricity-supply works in Britain have to make these returns annually.

The operating costs at Coventry are now the very lowest in the British Isles, though there are 30 undertakings having larger outputs, the largest being Manchester with sales of 94,000,000 kw.-hr. per annum, and as these works supply energy to the street cars, they have a load factor of 25 per cent. as compared with the 20 per cent. load factor at Coventry, which does not supply the street cars.

Even with these advantages, the Manchester costs are 1.10c. per kw.-hr., viz., 66 per cent. above those at Coventry.

The following are the detailed costs of Coventry for 1912:

COSTS PER KW.-HR. SOLD

	Cents
Coal	0.26
Engine room stores	0.02
Wages, generating station	0.10
Repairs, generating station	0.04
Distributing wages and repairs	0.10
Management, salaries	0.06
Establishment charges	0.02
Rent, rates and taxes	0.06
Total	0.66

The profit earned on capital invested was the highest of any electricity-supply works in the British Isles, being 12.48 per cent.

For the year ending Mar. 31, 1913, the sales have increased to 13,337,482 kw.-hr., and the profit on capital to 13.04 per cent., the average price obtained being reduced to 2.12c. per kw.-hr.

The following is a summary of results obtained:

SUMMARY

Old Regime		New Regime	
Put on local taxes	$61,250.00	Given to local taxes	$86,500.00
Annual loss	11,250.00	Annual profit	92,470.00
Capital expended	379,065.00	Capital expended	$1,658,200.00
Cost operating per kw.-hr.	6.12c.	Cost operating per kw.-hr.	66c.
Cost per kw. installed	689.00	Cost per kw. installed	$138.00
Many accounts charged to capital which should have been charged to revenue		Many accounts charged to revenue which might have been charged to capital.	
Surrounding districts assigned to a company.		Municipality granted power in surrounding districts.	
Yearly revenue	29,485.00	Yearly revenue	$298,430.00
No reserve fund		$300,000 placed to reserve.	
Gross profit on capital		Gross profit on capital	13.04%
Average for year	2.2%	Averaged for year	
Capacity of plant, kw.	550	Capacity of plant, kw.	13,000
Load factor	10%	Load factor	20%

New Continuous Chart-Recording Instrument

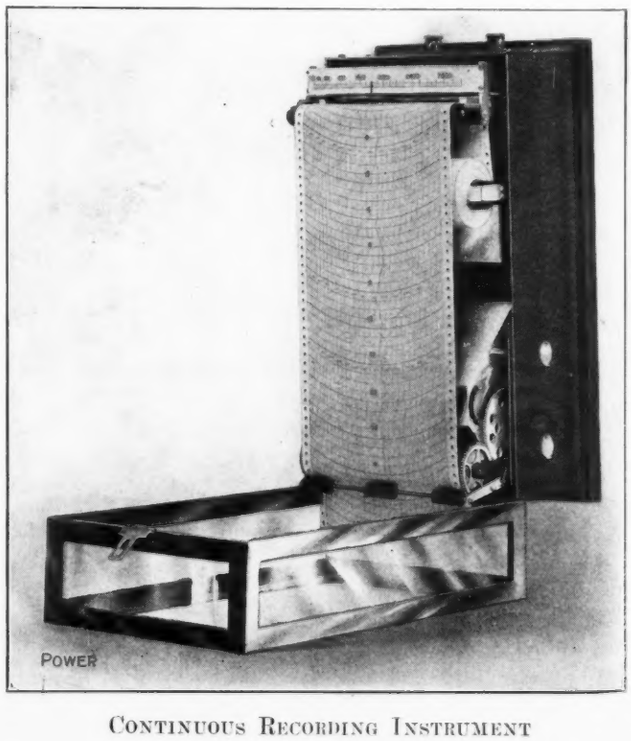
A new type of continuous-recording instrument for use as an electrical pyrometer for recording temperatures, and also as a recording voltmeter or ammeter has recently been placed on the market by the Brown Instrument Co., and the Keystone Electrical Instrument Co., Philadelphia, Penn. The instrument is simple in construction and compact in form. The case is 15 in. high by 8 in. wide, and projects from the switchboard or wall 7 in. The space occupied by the instrument has been largely reduced by placing the clock mechanism behind the record chart instead of to one side, and the record chart is the only part shown on the face.

A two-months' roll of record paper is used. It is necessary to wind the clock once a week. The complete instrument with a record on the recording chart is illustrated herewith. One scale is placed above the record so that the indications are visible at all times, and the scale is printed on the paper for direct reading.

The paper runs over a table at the top and is driven by a clock mechanism, the paper rolling out from the bottom of the instrument. A ribbon similar to those used in typewriters passes over the record paper and a mechanism depresses the pointer against the ribbon, which, in turn, is depressed against the record at intervals as desired. Dots forming the record can be made from 5-sec. up to 1-min. intervals.

Record paper can also be had with a coated surface, which does away with the ribbon, and the pointer striking the paper makes small dots on this coated surface. This is a specially prepared paper of patented form which requires no fixitive solution to preserve the record, and while the record is legible the paper cannot be smeared in handling.

This continuous-recording instrument will prove particularly advantageous for use as an electric pyrometer in conjunction with thermo-couples, for resistance thermometers for measuring low temperatures, or for recording volts or amperes. As the d'Arsonval frictionless type of direct-current instrument is used to prevent lag in the readings, a sensitive and accurate instrument is secured



CONTINUOUS RECORDING INSTRUMENT

Editorials

New York State to Economize on Coal

Suppose a corporation using approximately 320,000 tons of coal a year at $3.50 per ton were to effect by intelligent purchase a saving of 25 cents per ton. This would amount to $80,000 per annum—an item worth striving for.

Although the conditions of price and saving as given above are not true of the purchase of coal by the State of New York, the coal consumption of its various institutions is approximately the figure stated.

One of the channels through which Governor Glynn hopes to effect economy is that of the purchase of coal by specification for all state institutions. Heretofore, the purchasing committees of the various state departments have each purchased coal in its own sweet way. These committees have formed themselves into a joint committee to purchase coal for all institutions. The coal will be bought in large amounts, and distributed to the various departments as required. This should result in considerable saving, as those in charge of most of the state departments are physicians who have little knowledge of the importance of the quality of fuel to say nothing of approved methods of purchase.

About two-thirds of the coal used is anthracite. All coal will be bought by specification and on a heat-unit basis. The ton, both long and short, has been eliminated, and the unit of weight on which the heat value and price is based is 1000 pounds. No limit has been placed on the moisture content, Charles G. Armstrong, of New York City, who drew up the specification, claiming that this is something the miner or dealer cannot well control. For all the anthracite grades, the allowable limit of volatile combustible is 30 per cent., and the limit for sulphur is two per cent. The limit in percentage for ash is 11 for broken and egg, 12 for chestnut, 17 for pea, and 18 for No. 1, 19 for No. 2, and 20 for No. 3 buckwheat grades. Twenty-two per cent. ash is allowed in slack and refuse. The lowest allowable heat values vary from 13,400 B.t.u. for broken and egg, to 12,000 for No. 3 buckwheat. For soft coal (run of mine and lump chestnut) the allowable limit of volatile matter is 30 per cent; that of sulphur, 2 to 2½ per cent., and for ash, 10 per cent. for all grades of soft coal.

The advantage claimed for the allowable high volatile content in soft coal is that it broadens the field of available supply, and will, therefore, create keen competition for the state's coal business.

Three seven-pound samples of each shipment will be taken; one will go to the contractor or dealer, one to the chemist, and one will be retained for the determining analysis in case of dispute by dealer or user. In case of dispute, the Bureau of Mines, at Washington, will make this analysis which shall be final. Dealers will be penalized for shipments inferior in quality to that specified, and will receive a bonus when the quality is better than called for.

In addition to the saving realized from more intelligent methods of buying, there are other possibilities for saving: Nearly all of the state plants now using egg and chestnut coal can use broken coal with equally good results. The latter grade of fuel costs about 50 cents per ton less than chestnut and 25 cents per ton less than egg and stove. By using much more broken coal an appreciable saving will result. Many of the state buildings are in comparatively isolated places, and the boilers of many have stokers or Dutch-oven furnaces. Coal of high volatile content and of proportionately lower cost may, therefore, be used without producing objectionable smoke.

The state should follow up this work by further economizing in the use of fuel by making slight corrections in the boiler-room practice. Leaky settings may be repaired and the firing methods changed to advantage. Mr. Armstrong claims that with proper attention to boiler-room practice in connection with the intelligent purchase of coal, a saving of at least $250,000 a year may be realized.

What state will be next to follow New York in this plan?

Pass It On

Look over the trade periodicals on your desk this morning; also step out in the back room where you keep your office supplies and take stock of the publications you have piled away for future reference. There must be quite a stack of them out there gathering dust and occupying much needed space. How many times have you gone into that supply room to run through the back numbers and dig out an article you recollect vaguely of having seen some time or other? Not very often; have you?

Again consider those magazines just laid on your desk among the morning's mail. Do you go through them carefully? The chances are that when you pick up one, you turn the pages quickly, noting only the illustrations, until you come to an article bearing on your own particular product. This you skim over hastily, or digest carefully, as the importance of your correspondence allows. Again you move along rapidly, stopping a moment to note market quotations, until finally you toss the magazine to the back of the desk, with the mental remark that you will look through it again when you have more time.

How many men in your organization, or under your orders, ever see that paper to which you can spare only a scant quarter of an hour? Many of those men are ambitious; some are real thinkers. They may need only the word picture of how other men are solving problems common to your business to start them to thinking about the unconquered difficulties right in your own plant.

More than one great manufacturing organization of the present day owes its success to the discovery of the simple truth that the more brains there are focused on certain problems, the better chance those problems have of being quickly and surely solved. Trade books and

publications so disposed that they can be looked over and their articles of interest discussed during leisure moments, such as the noon hour, make one of the best ways of awakening interest in the work at hand.

Did you ever think of the tremendous amount of labor required to analyze the latest developments and ideas in a particular field; to investigate the newest apparatus and processes; in short to produce a useful, readable business magazine? That periodical into which you look for a few moments contains the best thoughts of a score or more of men who are top-notchers in their lines.

Has your business got all the benefit possible out of that magazine which you will soon lay aside to continue the morning's dictation? Cannot some of those men, on whom you rely for the smooth and noiseless operation of the business machine, glean one more idea from its pages? Even one useful idea may mean thousands of dollars in plant economies or improved product.

Therefore; for the inspiration of your men and the advancement of your business; after you have read your trade paper, *pass it on.*

The Operating Engineer

Workmen of all trades are required to serve a certain apprenticeship before being given the stamp of efficiency. If a brick-mason, a machinist or a carpenter is needed for a certain piece of work, one is selected who has fulfilled the apprenticeship requirements, and a more or less satisfactory piece of work can be expected. The position held in the commercial world by the stationary engineer is unique. If an engineer is needed, how different the method of procedure! His efficiency depends entirely upon himself, and not upon a certain period of apprenticeship.

Many an engineer, after years of service in one plant, fails miserably in another. Why? Because he has not fitted himself for any position other than the present; he has become an automaton, with no thought of the future.

On the other hand, consider the progressive engineer. He keeps uptodate and is vastly different from the majority of men found in the trades, although, in nearly all cases, they are better paid. This engineer is looked up to; he is held in respect in the large office buildings. This is but just, for in what other profession is the member required to keep so well informed to meet its constantly changing conditions.

What are his prospects for the future? We are entering upon a stage where the concentration of power has its adherents as being the more economical. If such is true, then what of the future of the engineer? The fact that large stations, in a great many instances, can furnish light and power cheaper than can the isolated plant has not and can not prove the bugaboo to the operating engineer as some think.

In what respect will an employer hold his engineer if he will present an impartial report concerning the adoption of central station power, instead of waiting for the central station expert to do it (as he will)? Consider the two positions of the engineer under such conditions. Which engineer "sticks?" Which engineer is promoted to manager or superintendent? Surely not the one who waited.

The stationary engineer of the future need not fear the encroachments of the central station, for the results show that a better position awaits him.

Engineers and Engineers

In the correspondence columns of our March 10 issue, Victor Bonn submits a comment upon an editorial entitled "One-sided Development," which appeared in one of the August issues of POWER. The theme of the editorial in question was that professional people are so much absorbed in the details and intricacies of their subject, that they do not develop good selling ability for their own services, and that many of them employ others to conduct this business for them. Applying this condition to the engineer, the editorial read:

> **This arrangement among professional people has its lesson for the engineer. The competent, efficient power-plant engineer must have today enough book knowledge to entitle him to a place in professional ranks. In order to acquire this knowledge, he devotes all his spare time and energy to study and experiments along the one line—engineering—to the exclusion of thought and culture along other lines, including the art of conducting business.**
>
> **No wonder, then, that he is underpaid, which means simply that he has not, as a rule, acquired the business ability needed to sell his own services at a price which represents their real value.**

Mr. Bonn suggests that it is equally necessary to educate the employer to safeguard his interest by employing a really competent engineer, which is all too true. The power-plant engineer—and we mean here, the real engineer, with that combination of knowledge of principles and experience in its application which is truly professional—is a development of the past few years, and power-plant owners generally have not come to differentiate him from his prototype, who was simply a more or or less skilled mechanic. The observation does not apply to the man, who, as Mr. Bonn says, drifts into firing because he can make a couple of dollars a week more than a common laborer, and is after some years promoted to run the engine with a little raise in pay. Such a man can, by study and an intelligent use of the opportunities afforded by his situation, make an engineer of himself, in the sense in which the term engineer was used in the editorial; but he is not such an engineer simply because he turns steam into and squirts oil at an engine.

Some time ago, there came an impatient 'phone call to the editor: "What kind of a man was that you sent down to me?"

"That was a thoroughly good, reliable Corliss egineer."

"Yes, I haven't any doubt that he could run our engine all right, but we want a man who can run the plant."

A striking instance of the difference between an engineer and an engine runner is afforded by the experience of a friend of and contributor to POWER, who less than a year ago, accepted a position as engineer of a company having a number of plants. Instead of losing himself in the petty details of the situation, he got out his note book and pencil, inquired into the amount of coal that was being used, the work that was gotten out of it, the price that was paid for it, the source of its supply, the number of boilers, square feet of grate surface, etc., that was used to burn it, with the result that by a change of supply and method of use, he effected a saving of over $100,000 per year and had his salary doubled before he had been with the company eleven months.

Correspondence

A Simple Filter

A simple and easily made filtering device that can be used for taking dirt or other solid substances out of nearly any kind of liquid is herewith illustrated. It is made on the "water-bottle principle."

Two bottles, a funnel and some waste are all that that

Oil Filter

are needed, or one bottle, a funnel and a pan would do as well. Charcoal or any other filtering material commonly used can be placed in the funnel.

S. F. Wilson.

New York City.

Hickory as Cylinder-Head Material

Frequently the man who runs a mill or factory is called upon to meet emergencies that make him think hard to figure the best way out of the difficulty.

A case of this kind came up not long ago. The cylinder head of an engine furnishing power for a lumber plant blew out, and it stopped operations immediately. To make matters worse, several rush orders for lumber were on hand and it was imperative that the plant be put in operation again at the earliest possible moment.

The superintendent packed the broken cylinder head and shipped it by express to a machine shop located in a near-by city, with instructions to rush a new head back at once. He was informed that it would be four or five days before shipment could be made as the head would have to be cast.

It was impossible for the plant to remain idle for that length of time, and the engineer realizing the necessity for getting up steam again as quickly as possible, suggested that a temporary head be made out of a piece of hiskory. The superintendent laughed at the idea but finally decided to try it.

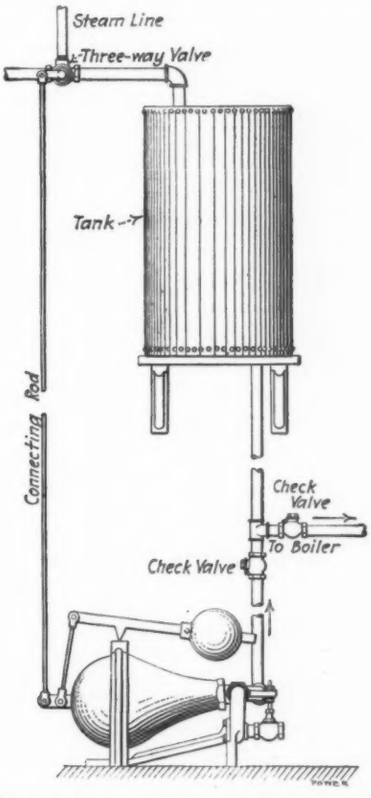
A piece of well seasoned hickory about 3 in. thick was shaped and drilled and bolted on the cylinder. The hickory head was used on the cylinder until a new cast head could be got from the machine shop, and it was then taken off and laid aside to be used for future emergencies.

G. M. Rittelmeyer.

Jackson, Miss.

One Trap Does Work of Two

This sketch illustrates how one return steam trap can do the work of two in feeding low-pressure drips or open heater water into the boilers and can be used under any pressure high or low. The arrangement consists of an ordinary return trap which discharges into an elevated tank of about equal capacity*. The tank should be ele-



Trap Connected to Do Work of Two

vated sufficiently to give a slight static head over the water in the boiler. A three-way valve or its equivalent alternately admits and releases the steam to and from the tank in the same manner as in the trap, but the reverse order in point of time. In the illustration the valve is

operated by the return tilt trap by means of a light rod or other suitable arrangement. This is convenient when the tank can be located directly above the trap but the tank may be located at any suitable point and the three-way cock located at or near the trap and connected to the elevated tank by a small steam pipe. The check valves in the figure open in the direction of the small arrow. If applied to a stationary or nontilting trap a small steam pipe is connected from the top or steam space of the trap to a diaphragm-operated three-way valve which takes the place of the type of valve first described.

The action in this case is as follows: When the steam pressure is on the trap in the act of discharging the water from it, the same pressure is on the diaphragm, closing the steam valve and releasing the pressure from the tank so that the water from the trap meets no resistence therefrom, but as soon as the trap is emptied and is relieved of the steam pressure the diaphragm of the valve is also relieved of pressure and the valve opens the steam line, thereby admitting steam pressure above the water in the tank and discharging it into the boiler. The diaphragm-valve construction is, of course, also applicable to a tilt trap. In either case there is no difficulty in feeding high-pressure boilers for the reason that only the packing of the one small three-way valve is subject to high pressure, a fact that will be appreciated by all users. Since there is no motion or vibration the tank may be placed on any support which will carry its weight or even suspended from the ceiling of the roof at a considerable elevation above the return trap which elevation will hasten its discharge.

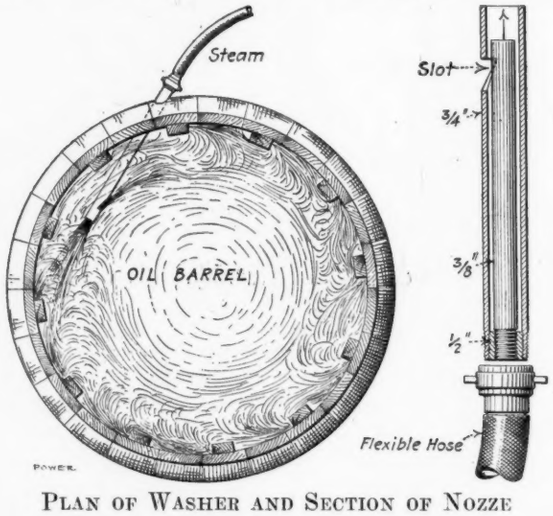
*The engraving unfortunately shows the tank much larger than the trap. They should be, as our contributor says, "of about equal capacity." Otherwise the steam used to discharge the water from the tank will be excessive in proportion to the amount discharged.

LEON LEWIS.

Washington, D. C.

Steam Washer for Cleaning Overalls

The accompanying sketches show an arrangement a fireman in our plant made for washing overalls after



PLAN OF WASHER AND SECTION OF NOZZLE

considerable experimenting with several similar ideas, none of which was so satisfactory as this.

The outfit as shown consists of a barrel with an injector-like apparatus which may be connected to a steam main through a flexible hose connection. Around the sides of the barrel is a series of vertical slats to break up the steady rotation of the water which the injector action gives and to set up counter-current, so that the clothes to be washed are thoroughly agitated.

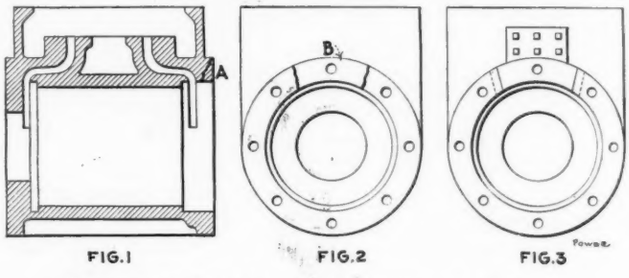
The barrel is an ordinary oil barrel; the injector was built up of three standard sizes of pipe assembled as shown in the sketch.

ARTHUR S. WELLS.

Ithaca, N. Y.

Broken Cylinder Patched

Figs. 1 and 2 show how the cylinder of an engine was damaged by a follower bolt working loose and being jammed between the cylinder and piston. The cylinder



SHOWING CRACK AND MANNER OF REPAIR

head was also broken. It was at first thought that a new cylinder would have to be purchased, but a good repair was made to the broken one by patching it.

A pattern was made and a brass patch cast. The end of the cylinder was dovetailed to receive the patch shown in place in Fig. 3. The patch was coated with a mixture of red lead and oil and tried in the cylinder to get impressions for making a steam-tight fit. After the face of the steam chest was drilled and tapped the patch was driven in place and bolted. A portable boring bar was used to face off the parts after the patch was bolted on. The patch was calked around the joints and has served its purpose without trouble.

ROBERT P. HARRIS.

Washington, D. C.

Position of Joints in Snap Rings

It would seem that if snap rings were made a good fit in their grooves, and a good fit to the cylinder, that they should work equally well with the joints in any position, whether it be at the top, bottom or side of the cylinder.

Such is not the case, however, especially after the piston is worn; at least, this has been my experience. The piston in one cylinder of a two-cylinder, single-acting twin, gas engine leaked badly. It was supposed that a ring was broken, but when the piston was removed, the rings were found to be in good condition. Neither could anything be noticed that would account for the leakage. There was a clearance mark on the piston rod and when the piston was replaced, care was taken that the rod was screwed into the crosshead until this mark was in proper

position. On starting again, the blowing had ceased, but after a short run it developed again.

The engine was stopped and an examination showed that the piston and rod had turned so the joints in the rings faced the side of the cylinder instead of the bottom. After correcting the position to check with the original marking and locking the rod securely in this position, no further trouble was experienced.

I had noticed that the joints in the snap rings of horizontal gas-engine pistons were always placed on the bottom of the cylinder and I was careful after cleaning to put them in that position, but I had never thought that this location of the rings would make so much difference in their functioning.

Upon reflection it is plain why this condition should be. The weight of the piston holds it to the bottom of the cylinder and the rings lie completely in their grooves at the bottom of the cylinder and out in the grooves as far as the cylinder will let them, at the top.

This being so, it can readily be seen that when the joints are at the bottom, they are subject to very little pressure, as the piston makes a close fit with the cylinder walls on the bottom, and the rings make a close fit with the cylinder walls on the sides and top. If the joints were placed on top, a path would likely be found through the joints.

EARL PAGETT.

Coffeyville, Kan.

Plant vs. Purchased Power for Department Store

I noted in the issue of Jan. 27 the report by F. W. Rose, showing the costs in a department store operating its own plant as compared with purchased power. The costs for central-station service are given but there is no note of the kilowatt-hours furnished or any other information which will enable a proper comparison to be made. Furthermore, the maximum load on the plant under central-station service and with the isolated plant is not given. This is important in comparing total costs for service.

In Table 2 the expenditures for a year, which includes part of 1912 and part of 1913, are given and there appears to be some marked discrepancies. Take the item of coal cost per kilowatt-hour generated. This varies widely as shown by the following which I have calculated from the data given:

Sept. 1912, coal cost = 2.35c. per kw.-hr.
Oct. 1912, coal cost = 1.62c. per kw.-hr.
Nov. 1912, coal cost = 2.36c. per kw.-hr.
Dec. 1912, coal cost = 1.05c. per kw.-hr.
Jan. 1913, coal cost = 1.51c. per kw.-hr.
Feb. 1913, coal cost = 2.76c. per kw.-hr.
Mar. 1913, coal cost = 2.39c. per kw.-hr.
Apr. 1913, coal cost = 1.26c. per kw.-hr.
May 1913, coal cost = 1.03c. per kw.-hr.
June 1913, coal cost = 2.61c. per kw.-hr.
July 1913, coal cost = 0.89c. per kw.-hr.
Aug. 1913, coal cost = 1.98c. per kw.-hr.

Note the wide variation of these costs from 0.89c. to 2.76c. and apparently the coal cost bears no relation whatever to the load on the plant.

The statement is made that only one 200-hp. boiler was used at any time in the operation of the plant. Assuming this to be correct and that the resultant maximum electric load would not be over 200 kw., the published rate sheet of one of the large city plants can be applied to this installation. Under this rate schedule referred to, a customer for 200 kw.-hr. of maximum demand can obtain 378,330 kw.-hr. during the year for the net sum of $10,387.47; an average rate of about 2¾c. per kw.-hr. The foregoing calculation is for standard low-tension direct-current service. If low-tension alternating service could be used, the annual charge would be at least 10 per cent. lower than the amount stated.

In the cost statement noted in Table 3, the average cost per kilowatt-hour for the same number of kilowatt-hours annually, figures out 4.37c. per kw.-hr.

In view of this comparison, it seems that considerably more information is required in order to show any particular saving through the ownership of the isolated plant in question, particularly if the fixed charges are made up on a proper basis instead of simply at legal interest rates.

G. E. WENDLE,
Lycoming Edison Co.

Williamsport, Penn.

In reply to the criticisms of Mr. Wendle, I wish to take them up in the order in which he has made them:

1. KILOWATT-HOURS OF CENTRAL-STATION SERVICE—No mention was made in the original article of the kilowatt-hours used from central-station service, because the only year in which the comparison would have been at all of value was the first year, and that year the current was purchased under a flat rate, and for the other years the current used from central-station service was just enough to keep above the minimum charge for the emergency connection.

2. MAXIMUM LOAD—No records have been kept of the maximum load, but at no time with the Saturday-night load, or during the holiday season when the store is open evenings, is the 200-kw. unit overloaded. Ordinarily, the smaller unit carries the load, which much of the time is more than full-load rating of the generator, often a momentary overload of 75 per cent.

3. COAL COSTS—The items under "cost of coal" were taken from the books of the company as the bills were paid. This will account for the apparent discrepancy, for it does not follow that the coal paid for in any one month was used in that month.

The high coal cost for the year 1910-1911 was due to 24-hr. service being maintained for nine months, or until the emergency service was connected, and for a number of weeks during that time the small generator was out of commission and it was necessary to run the large unit, which was uneconomical on the small loads.

Another item which was omitted in publishing, was that the plant supplied high-pressure steam and hot water for two kitchens in the store.

4. COST PER KILOWATT-HOUR—In figuring the cost per kilowatt-hour, Mr. Wendle has not taken into consideration the fact that this plant also furnishes heat, ventilation, live steam for the kitchens and hot and cold water for all purposes, and that in the total costs of operation are included the maintenance of all the above items as well as of the plumbing and of an automatic sprinkler system for the entire store.

In the original report no attempt was made to figure the cost per kilowatt-hour, as in a proposition of this kind it is practically impossible to separate the various items so as to arrive satisfactorily at the correct cost per kilowatt-hour.

If the cost per kilowatt-hour were figured by taking the "Cost Less Purchased Current" for the year 1912-1913, and take from this the corresponding cost for the year 1909-1910, then the charge against the current would be $6581.64, which is 1.21c. per kw.-hr. This figure, which is not absolutely correct, is much nearer the cost than the 4.37c. as figured by Mr. Wendle.

The only satisfactory way of arriving at comparative costs where the generation of electricity is a byproduct, so to speak, is to take the total costs of the power department.

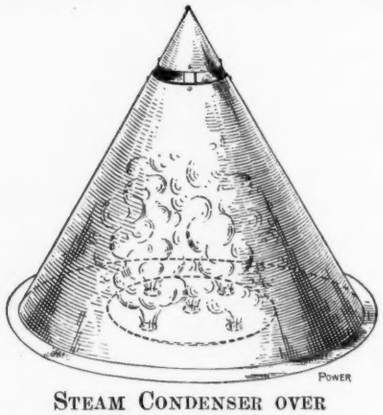
5. FIXED CHARGES—I will not enter into a discussion of the fixed charges, as there is a great difference of opinion on this subject, but there are a large number of business houses which recognize this as a factor, but do not carry more than 12 per cent. on their books, and some not as high as that.

F. W. ROSE.

Minneapolis, Minn.

Eliminating Steam Vapors

Steam has a disagreeable faculty of showing itself conspicuously to the detriment of the prestige of the engineer-in-charge. One particular place is at manholes on long underground systems, such as are used in the streets of cities, and the grounds of large public and private institutions, causing comment and criticism which is not often just. At the present time, there does not appear to be any system of joints which will remain absolutely tight after a year or so of service, especially where right-angle joints occur, and it would be foolish to endeavor to remedy the matters by taking up and relaying the system. The best thing for the engineer to do is to eliminate the steam where it occurs, and this can be done by building copper casings over them as shown in the illustration. An opening is provided near the top, as if a small section or frustrum of the cone were removed. The manner of securing this casing or hood in place will depend upon



STEAM CONDENSER OVER MANHOLE

conditions, but in most instances it is preferable to securely fasten it to the surrounding construction, and not removably so, that is, simply fastening it to the manhole cover is not desirable.

This arrangement will effectively condense the vapors and steam coming into the manhole and trying to escape through the casing, mainly because a large cooling surface is provided and arranged so that all the steam must make contact with it. The opening at the top serves to provide ventilation for the manhole, to permit air to circulate in the casing and thereby keep it cool, and also to provide an arrangement whereby the coolest part of the device is in the best location. The casing also provides a relatively large surface for the wind or outside air to cool.

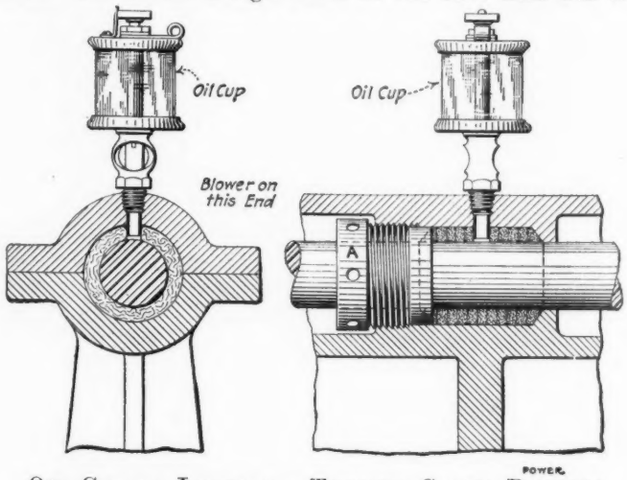
It is preferable that the casing be made of copper because of its longevity and also because in aging it becomes a green color which makes it less conspicuous on grass. Bent tin or galvanized iron would in many cases be just as suitable. The arrangement is one which can be modified to suit other places where it is desired to condense steam and will always be found to be effective.

A. P. CONNOR.

Washington, D. C.

Lubricating Turbine Packing

A steam turbine-driven blower set had been installed in place of the belt-driven blower formerly used for draft. The turbine company by its contract sent a man every six months for a year and a half to examine the turbine. One of the things which he did each time was to



OIL CUP TO LUBRICATE TURBINE GLAND PACKING

pack the two stuffing-boxes—one on each side of the unit. A continuous shaft passed the entire length of the set so that one stuffing-box came between the turbine and the blower.

This stuffing-box is shown in the sketch. The packing inclosing the shaft revolving at high speed, needed lubrication which was furnished by a large oil cup set into the cast-iron cap having a $\frac{3}{16}$-in. hole leading from it to the packing space.

The factory men always furnished their own packing and never informed the attendants as to its kind. After the contract had run out, the attendants had occasion to pack the stuffing-boxes and put in piston-rod packing such as was used on other engines. The stuffing-box on the free end of the shaft never gave trouble, but the inside one was an annoyance from the start.

To remedy the trouble a larger oil hole was drilled and a piece of brass tubing driven in, projecting through so that it just cleared the shaft. The back end of the stuffing-box was packed in the usual manner, then two loops were cut short and the gap between the ends brought to the top. In this gap the tube extended and carried oil to the shaft. The oil then fed satisfactorily.

D. A. HAMPSON.

Middletown, N. Y.

Inquiries of General Interest

Coking Fire—What is meant by a coking fire?

J. G.

One which is stoked at the front and the coal shoved to the back when it has become coked.

Trying Safety Valve—How often should a boiler safety valve be raised?

J. C.

To be assured that the valve has not become stuck on its seat, the valve should be lifted or caused to pop at least once every shift.

Use of Mechanical Stokers in Marine Service—What difficulties are in the way of using mechanical stokers on steamships?

E. T. D.

The principal difficulties to be encountered are in the arrangement of conveyors, lack of sufficient deck space and head room and disturbance of the fire from the motion of the vessel.

Trouble with Rope Drive—In starting up a rope drive with slack ropes, the ropes run out of the grooves of the guide shieves used for changing the direction of the ropes. What may be the cause and remedy?

L. I.

The trouble may arise from delivery of the ropes on the pulleys at different inclination to the planes of the pulleys than when the ropes are running under tension. The remedy probably would be to favor the sag by adjusting the pulleys to positions which are more nearly vertical.

Crumbling of Firebrick—What would cause crumbling and spawling of the firebrick lining of a furnace?

J. W. D.

Crumbling may be due to water contained in the firebrick when laid, or to their having become wet, or to absorption of moisture from the walls or the atmosphere when the boiler has been out of use. Spawling and also cracking of furnace walls may result from sudden cooling of the walls by leaving the furnace or draft doors and damper open when the fire is so low as to allow the walls to cool down too quickly.

Disinfecting by Steam—How is steam used for the disinfection of bedding, etc., and what form of apparatus is used?

J. A. G.

The heat of steam is used for disinfecting both by direct application of live steam and sterilization by radiation of heat. The special apparatus employed for the purpose, and which is known as a steam sterilizer, usually consists of a horizontal shell of boiler plate surrounded by a steam jacket space, and with a steam-tight door at each end. In the best forms provision is made for introducing steam to the interior and after sterilization is completed and the supply of steam has been cut off from the interior, moisture is carried off by a steam-jet exhauster while heating by the steam jacket is continued.

Greatest Movement of Valve.—With a shaft 15 in. in diameter and an eccentric of 5-in. throw, what is the greatest distance a valve could be moved by turning the eccentric ⅛ in. on the shaft?

W. H. C.

The throw of the eccentric being 5 in., its eccentricity would be 2½ in., and the shaft being 15 in. in diameter its radius would be 7½ in. The movement of the eccentric around the shaft, through a circumferential distance of ⅛ in., at a radial distance of 7½ in. if measured on the circumference of the circle having a radius equal to the eccentricity of the eccentric, would be

$$\frac{\frac{1}{8} \times 2\frac{1}{2}}{7\frac{1}{2}} = \frac{1}{24} \text{ in.}$$

and this would be practically the greatest distance a valve could be moved under the conditions stated.

Brake Horsepower of an Engine—What is the formula for computing the brake horsepower of an engine when using the prony brake?

J. H. C.

The formula is:

$$\text{brake horsepower} = \frac{2\pi \times L \times N \times P}{33{,}000}$$

in which

$2\pi = 2 \times 3.1416$, or 6.2832;

L = The effective length of the brake arm in feet, being the perpendicular distance from the axis of rotation of the brake wheel to the line of resistance measured;

N = The number of revolutions per minute made by the brake wheel;

P = The net resistance in pounds at the distance L from the axis of rotation of the brake wheel, while making N revolutions per minute.

Formula for Flow of Steam Through Pipes—What is the formula for the flow of steam through pipes?

S. E. B.

Unwin's formula, which has been accepted after extensive tests, is as follows:

$$W = 87.5 \sqrt{\frac{P y d^5}{L\left(1 + \frac{3.6}{d}\right)}}$$

in which

W = The flow, in pounds per minute;

P = The difference between the steam pressures in the entrance end and discharge end of the pipe, in pounds per square inch;

y = The density or weight per cubic foot of steam of the pressure at the entrance (to be obtained from the steam tables);

d = Diameter of the pipe in inches;

L = Length of the pipe in feet.

Reasons for Back Pressure—What are the reasons for back presure on an engine?

S. U.

Back pressure occurs from any cause which prevents the exhaust from reduction to zero pressure, or perfect vacuum, and may be due to one or more of such causes as: leakage of the piston from the pressure side; leakage of the admission valve during the return stroke of the piston; insufficient opening of the exhaust valve; closure of the exhaust valve before completion of the return stroke; contracted exhaust passages; insufficient size, obstructions, fittings and friction of the exhaust pipe; hindrance to free discharge through feed-water heaters or into an exhaust heating system; exhaust steam from steam pumps or other engines discharging into the same exhaust pipe or receiver; mingling live steam with an engine's exhaust for assisting an exhaust supply to a heating system; back pressure of the atmosphere when working noncondensing; friction of exhaust passages to a condenser or through a surface condenser, and imperfection of vacuum obtained when working condensing.

Conductivity of ½-In. and 1-In. Plates—What would be the practical difference in efficiency of conductivity of heating surfaces of a boiler whether composed of plates or tubes ½ in. thick or 1 in. thick carrying 150 lb. pressure?

A. C. L.

In operating a boiler under 150-lb. gage pressure the temperature of the water is 366 deg. F., and assuming the average temperature of furnace and flue gases as 1200 deg. F., the average temperature difference between the water side and fire side of the heating surfaces would be about

$$1200 - 366 = 834 \text{ deg. F.}$$

It has been determined from experiments on the transmission of heat through plates of various thicknesses and allowing 10 sq.ft. of boiler surface per horsepower, that the necessary rate of transmission of heat through heating surfaces ½ in. thick would require a difference of temperature of 12.8 deg. F., and for heating surfaces 1 in. thick, a difference of temperature of 25.6 deg. F. These differences are so small compared with actual conditions as to indicate that the conductivity of boiler plates and flues of the thicknesses ordinarily used, is practically the same for all thicknesses.

Engineers' Study Course

Elementary Mechanics--I

The purpose of this section of the course, as of all that have preceded it, is to give a working knowledge of the fundamentals of mechanics sufficient for all practical needs. For this reason, only an elementary discussion of mechanics will be attempted.

To begin with, a few definitions will be given to fix the meaning of such terms as will be used from the start, then will follow simple explanations of the principles involved and practical applications of these principles will be given as examples or exercises, which will be made as pertinent as possible to power-plant problems.

To the average person the application of a principle is more interesting than a mere understanding of the principle by itself. For this reason the first few lessons, which will deal with definitions and statements of laws, may seem rather dry, but the student is urged to follow closely these introductory lessons so that he may more readily grasp the applications that will come later. Many will find that much of the early part of the course is familiar to them, but to others there will be new terms or at least new light on their meaning.

Definitions

Mechanics is that branch of science which has to do with forces and their action on bodies tending to produce a state of motion, change of motion, or condition of rest of these bodies. At the outset it is essential that the student clearly understand that he is concerned only with forces and that all bodies will be considered as rigid, irrespective of the forces acting upon them.

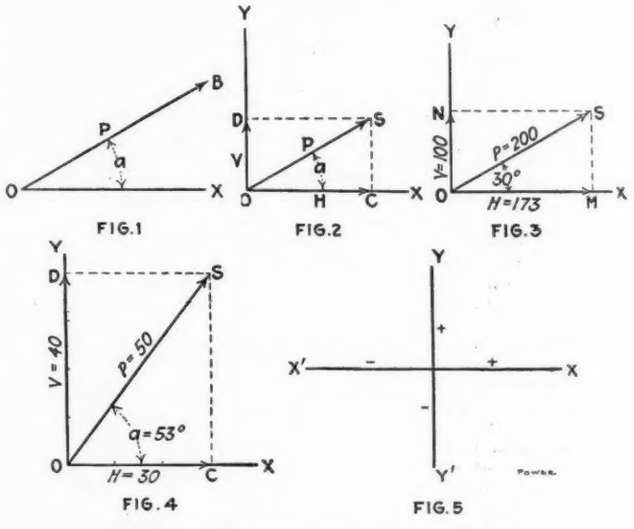
The study of forces is divided into two general subjects, *kinetics* which deals with the forces that produce or change the motion of bodies and *statics* which deals with forces that keep a body at rest or in a state of equilibrium. The term *dynamics* is commonly used to include both kinetics and statics.

Force is that which produces, or tends to produce, motion or change of motion of bodies. It manifests itself to the feelings by a tension or pull, and by a compression or push. In other cases it manifests itself by an attraction or repulsion. Assume a man pulling on a rope—it is evident that the man can exert no pull on the rope unless the rope be attached at the other end to a resistance. An engine remains at rest on its foundation only because the foundation exerts an upward pressure equal to the weight of the engine. Stated in the familiar law of Newton, "*to every action there is an opposite and equal reaction.*" Hence no single force can be exerted without there resulting an equal and opposite reaction. Another example is that of the pressure of the steam in a steam boiler. Suppose the steam pressure in the boiler is 100 lb. per sq.in. This means that on every square inch of surface in the boiler there is a pressure of 100 lb. The reaction is furnished by the material of the boiler, which, by virtue of its strength for each square inch is exerting a force of 100 lb. in resistance to rupture.

Gravity is the force by which all bodies are drawn to the earth. The force with which the earth attracts any body is called the *weight* of that body. Weight must not be confused with *mass* which will be discussed in a later lesson.

The unit of force is the weight of one pound or simply the pound.

Forces are represented graphically by straight lines; the *direction* of the force by an arrowhead placed at the end of the line and by the angle which the force makes with a given reference line; the *magnitude* of the force



Graphic Representation of Forces

by the length of the line. Three things are then necessary to completely determine a force:

(1) The point of application of the force.
(2) The direction of the force.
(3) The magnitude of the force.

In Fig. 1, O represents the point of application of the force P. The angle a gives the direction of the force with respect to a horizontal reference line OX, and the arrowhead at B indicates that the force is acting from O to B and not from B to O. The length of the line OB indicates the magnitude of the force P. Thus if 1 in. of length represents 50 lb. and the line OB is 2 in. long, then the force is

$$P = 2 \times 50 = 100 \text{ lb.}$$

Components of Forces

The effect of a force in any given direction is called the *component* of the force. For convenience in dealing with problems, forces are generally resolved into their horizontal and vertical components. The component of a force can never be greater than the force itself and no force can have a component at 90 deg. to the line of action of the force. It must be evident, then, that a force exerts its maximum effort in its own line of action.

When an engine is on dead center the pressure of the steam on the piston has no component tending to rotate the crankpin for the simple reason that at the given instant the motion of the crankpin is at right angles to the motion of the piston.

A force may have an infinite number of components. These components may be determined either graphically or by the aid of equations.

In Fig. 2, let OX and OY represent the horizontal and vertical reference lines drawn through the point of application O of the force P. Let the length of the line OS represent the magnitude of the force P. The components of the force P are found graphically as follows: From the point S drop a perpendicular SC onto the line OX forming the intercept OC. The length of this intercept OC is the horizontal component of the force P. In like manner the length of the line OD represents the vertical component of the force P. It would be possible to find other components of P, but for the present only horizontal and vertical components will be considered. Let

H = Horizontal component OC of the force P;
V = Vertical component OD of the force P;
a = Angle which the force P makes with the horizontal.

Then by construction $OSCO$ is a right-angled triangle and from the laws of trigonometry the values of H and V can be determined in terms of the force P and the angle a, or

$$H = P \cos a \tag{1}$$

and

$$V = P \sin a \tag{2}$$

PROBLEM 1—A force of 200 lb. makes an angle of 30 deg. with the horizontal. Find the horizontal and vertical components of the force.*

SOLUTION—In Fig. 3, let OS represent the given force $P = 200$ lb. to scale; let angle $SOX = 30$ deg.

Construct the rectangle $ONSMO$ with OS as one diagonal. Then the line OM will represent the horizontal component H, and the line ON the vertical component. These lines can be measured and will give the numerical value of the components, or equations (1) and (2) can be applied and the components found. Thus, $H = P \cos a = 200 \times \cos 30° = 200 \times 0.866 = 173$ lb., and $V = P \sin a = 200 \times \sin 30° = 200 \times 0.5 = 100$ lb.

If the components of a given force are known the magnitude and direction of the force can be determined as follows: In Fig. 2, since $OSCO$ is a right-angled triangle,

$$P^2 = SC^2 + OC^2$$

(the square of the hypotenuse equals the sum of the squares of the other two sides), but $SC = OD = V$ and $OC = H$; therefore

$$P^2 = H^2 + V^2$$

or

$$P = \sqrt{H^2 + V^2} \tag{3}$$

The tangent of the angle is

$$\tan a = \frac{SC}{OC} = \frac{V}{H} \tag{4}$$

From the last equation the angle itself may be found with the aid of a table of natural trigonometric functions.

*Note—In the solution of problems in mechanics the student will find the work very much simplified if he will make a neat sketch showing the relative position and magnitude of all the forces involved, as well as their direction.

PROBLEM 2—The horizontal component of a force is 30 lb. and the vertical component is 40 lb. Find the direction and magnitude of the force.

SOLUTION—Lay off OD = 40 lb. and $OC = 30$ lb. to scale, as in Fig. 4.

Draw DS parallel to OC and CS parrallel to OD and draw the line OS which will represent the unknown force P. Then

$$P^2 = OD^2 + OC^2 = 40^2 + 30^2 = 1600 + 900 = 2500$$

Therefore,

$$P = \sqrt{2500} = 50 \text{ pounds}$$

$$\tan a = \frac{SC}{OC} = \frac{40}{30} = 1.333+$$

and the angle whose tangent is 1.333 is found to be 53 deg.

To aid in the problems that will follow later in the course, all components acting either to the right, or upward will be considered as positive forces (+), and all forces acting downward, or to the left will be considered as negative (—), as indicated in Fig. 5.

Forces which pass through a common point are called *"con-current forces,"* and those whose lines of action do not pass through a common point are called *"noncon-current forces."*

STUDY QUESTIONS

1. What is the broad term for the action of forces on bodies?
2. What is force; how does it manifest itself?
3. When steam is admitted to the cylinder of an engine, where does the pressure find its reaction?
4. What is the component of a force?
5. What is meant by the terms gravity and weight?

Venturi Meter

Old as it is, there are some who know the venturi meter by name better than by principle. They are inclined to think of it as a device with properties that are a bit mysterious, whereas it is really quite simple, when understood, and not at all difficult to understand, when analyzed.

The venturi meter is a modern application of a curious phenomenon known for many years. Where a jet of water or a stream is compelled by following pressure to hurry through a narrowing passage, its tendency to exert lateral pressure is reduced. It is possible with a well proportioned narrowing throat actually to cut away a pipe, and

VENTURI METER

the moving jet will jump the gap and continue in the pipe to move against the pressure without escaping laterally. This meter consists of a short throat in a pipe, and is joined to it by conical lengths. These compel the water to travel gradually more rapidly, and the throat velocity is several times that in the pipe at each side of it. Pressure gages on the pipe and on the throat will show different pressures, that of the throat jet being the lesser. This pressure difference is recorded in terms of gallons passing.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

Mon Dew! The French Feather Association has refused to exhibit at the coming Panama-Pacific Exposition. Here's another blow at our little show. How can we have an exhibition without a few French feathers? What's the matter, Messieur Jacques, are ze petite birds doing ze moult, or do you suffer ze pip because of your Oncle Sam's restrictions on those dear feathers from that gay Paree?

⁂

We are highly indignant that a suffragette should have smitten with an axe the rather speaking likeness of Miss Venus Rokeby, in the London Gallery. No gent would take an axe to a lady, and as we are led to believe that these suffering ladies want to be treated as real gents, this violent proceeding is ungentlemanly.

⁂

The British papers raised a bally rumpus when Cousin Thornton crossed the pond to assume charge of the Great Eastern Railway. And by jove, y'know, 'twas Lord Claud who chose the bounder! Now that Cousin Cooper, because of his good work at Keokuk, has been selected by Sir Ralph to help engineer the big Nile project— My word, old top, there'll be war among the engineering Johnnies at home, I'm thinkin', eh, what?

⁂

More honors for astronomic science! We ask a salute of 21 guns for Annie Jump Cannon, curator of astronomy at Harvard University. Annie has "distinguished the type to which a star spectrum belongs." Easy to see now why the London Society has bestowed honorary membership upon her. We would jump at this ourself if we could. In lieu of which we are glad to let Annie Jump.

⁂

To the printers' art we owe a great debt. Technical and trade papers, especially, owe their beauty, their typographical culture and their clarity to this art. And no one man has done so much to develop and beautify it as has Theodore L. De Vinne, who died recently. All honor to his memory!

⁂

The germers are at it again. This time it's the humble sandwich, which should not be eaten on grounds of dietetics or of economy. Can't somebody discover a harmful germ in the lubricating oil or a boll weevil in the cotton waste? Our vocation is running at slow speed with the fashionable trend.

⁂

Another startling thing, according to the papers, is that "marriage is a science." Poof! It's an exact science. We've known this for 25 years. If some of you young or soured single engineers are skeptical, try it. Trying's believing.

⁂

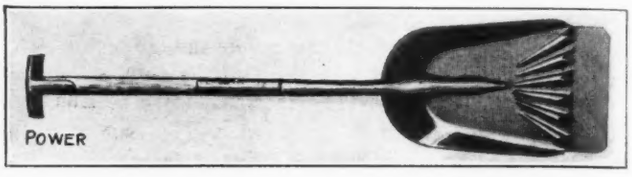
"Imperator" Is a New Ship—Headline.

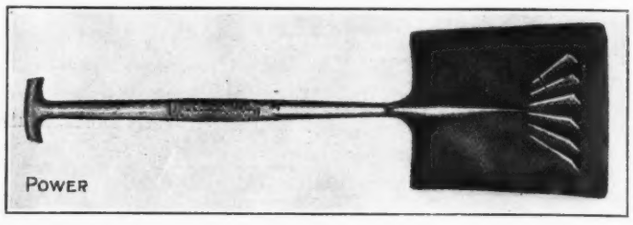
Before her recent extensive alterations she was said to be "tender" (likely to roll). It's pretty tough for a new ship to be so tender that it takes a roll of 5,000,000 marks to keep her from rolling. Another alteration has provided better accommodations for the firemen. That's real human in a world where firemen are commonly considered—well, just firemen, until they jump overboard. Then they're crazy.

LOOKS LIKE THE NIGHT MAN WAS GOING TO HAVE A "PIPE"

"Fire King" Sprinkler Shovels

These shovels have been designed chiefly for boiler firing, to insure better results with cheap grades of fuel, by assisting the fireman in sprinkling it thinly over the fire. Unless a fireman is expert, the fuel leaves the





TWO PATTERNS OF "FIRE KING" SPRINKLER SHOVEL

shovel in a thick mass, requiring several shovelfuls to cover the surface of the fire. The result is that the fire is covered with a thick layer of green fuel, which cools the furnace, and retards the admission of air at a time when the maximum quantity is required for the combustion of the liberated gases.

The sprinkler shovel is made with six raised ribs pressed from the steel plate of which the shovel is made. The ribs are made at an angle from the center toward the outsides and front edges of the shovel, as shown in the accompanying illustration. The idea is that as the fuel leaves the shovel the ribs give it the spreading or scattering effect, desirable with hand firing.

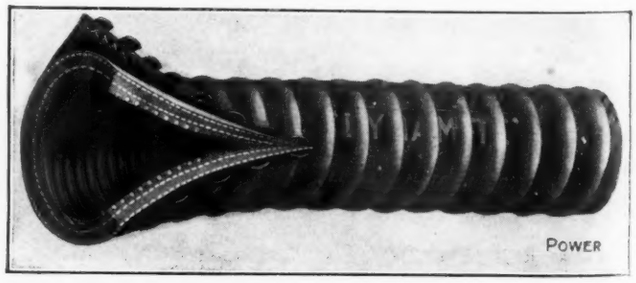
This shovel is made by Clarence A. Fell, Dronfield, near Sheffield, England, who also holds the United States patent.

⁂

"Dynamite" Flexible Metallic Steam Hose

If a steam hose is not properly made, the inner tube will soon buckle and become broken, and, although sections of the hose may be fit for use, the defective parts condemn the whole.

A design of hose which appears to be so constructed for long service is illustrated herewith. It is made with an inner protection of spiral wire embedded in rubber, to prevent collapsing. Then comes a ply of heavy duck, shown by the white dotted line. Next is the tube proper,



CUT SECTION SHOWS HOW THE HOSE IS CONSTRUCTED

then a second ply of heavy duck, and a rubber cover. Over this is placed an armor-braided covering of nonrustable, annealed steel wire. This covering will withstand a working pressure of over 1000 lb. per sq.in., and takes care of all strains due to internal pressure.

The braided covering is spirally wound with half-round nonrustable steel wire, which takes care of any external wear to which the hose may be subjected. The spirals do not crowd together and if they are cut they will not loosen.

This hose, made by the Malconroy Co., 722 Arch St., Philadelphia, Penn., will not kink or collapse. It is specially adapted for boiler testing, blowing tubes, and where high steam or air pressure is to be used.

The Care of Wire Rope*

SYNOPSIS—A kinked rope may be straightened but the rope will be weakened. When a running rope has a socket attached to the end, water may collect and cause corrosion; the remedy. Rapid deterioration of ropes is often due to corrosion that could have been prevented by the use of a lubricant which would have reached and protected the inside wires.

Experience has taught that there are four leading causes for the destruction of wire rope, namely, abrasion, overstrain, undue bending and corrosion. In time, one or more of these causes will so weaken a rope that it can no longer support the load for which it was designed. When it fails, from any of the above mentioned reasons, the cause can usually be determined from the appearance of the rope. If, for example, the wires wear thin in a short time, the rope has been subject to abrasion; if the wires are but little worn and broken off squarely, usually sticking out all over the rope, it has suffered from either severe bending stress or overstrain; and if the wires are rusty and pitted, corrosion is to blame.

Causes of Abrasion

Abrasion in a wire rope is frequently the result of one of the following causes: (1) Faulty grooves in wheels that are roughly worn or too small for the rope.

(2) Dragging of the rope upon the ground or over some fixed obstruction.

(3) Using a rope under conditions for which none but the toughest steel (plough or improved plough) is adapted, and failing to select ropes of such grades.

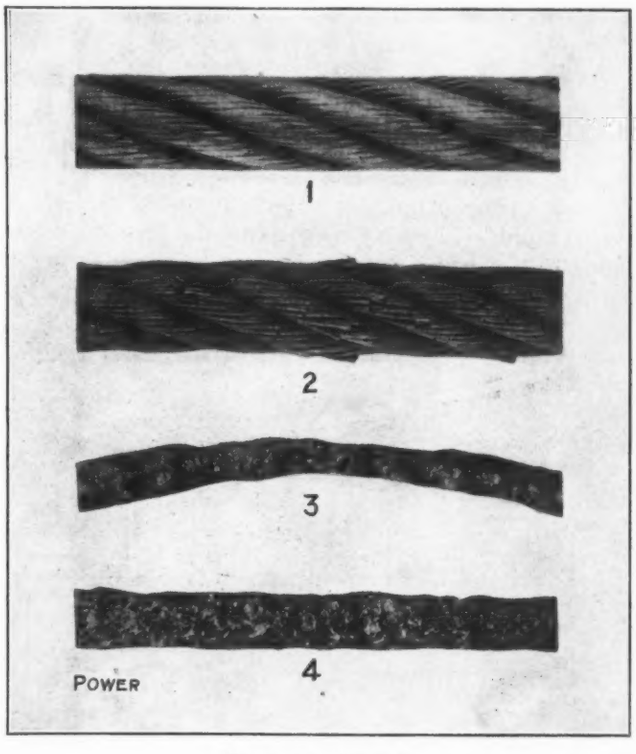
Another cause for sudden breaking may be excessive abrasion at some point. This may occur to ropes running on slopes over heavy knuckle sheaves. After the train has come to a rest, if the sheave keeps on spinning, it tends to wear the portion of the rope resting upon it, and that part will slowly wear and become weak.

Causes of Broken and Corroded Wires

Badly broken wires, showing excessive bending, indicate that the wheels are too small or too numerous. They should be rearranged or a more flexible rope used.

Rope badly corroded shows the lack of proper lubrication. Local corrosion sometimes causes failure. If, in passing through a place in which water is dripping from the roof, a rope is allowed to lie still for a considerable length of time, the part exposed to the drippings will rust faster than the rest.

In addition to the destructive causes mentioned above, ropes sometimes suddenly tear apart. Such cases are invariably the result of accidents to machinery or appliances, which bring upon the rope a load far beyond its capacity, or they are due to a serious weakening of the rope at the point of rupture, caused by some local abuses. Such abuse should by all means be avoided. A new rope made from the materials and with the care that distinguishes "A-1" quality, is sent from the factory as nearly perfect as a mechanical product can be and the purchaser should protect the rope from those injuries which may with very little care be prevented.



Rope in Service

1—Wire Rope Used under Proper Conditions, Shows Normal Wear. 2—Wire Rope that Has Been Subjected to Short Bends, Causing Broken Wires. 3 and 4—Enlarged Views of Pieces of Wire Taken from Badly Rusted Rope.

One of the most common of these injuries is the damage arising from "kinking." If for any reason the rope is allowed to form a loop, and this loop is drawn taut, a kink will result. Though the kink may be straightened out, it leaves a permanently damaged and weakened spot and so should always be avoided.

When a running rope has a socket attached to the end, constant vibration tends to weaken the wires, and this weakness is increased if water collects directly over the end of the socket. It is, therefore, advisable every three to six months to cut off a piece from the end of the rope and reattach the socket.

*From the January issue of the "Employees Magazine," published by the Lehigh Valley Coal Co., from material furnished by the John A. Roebling's Sons Co.

Besides the causes mentioned, the effects of which are usually revealed by inspection, temporary overloads producing excessive stresses are sometimes applied, and by straining the wires beyond their elastic limit these tend to shorten the life of wire rope. Such excessive stresses are more apt to occur where a rope is slack, or is attached to a short length of slack chain, and the power to lift or haul a load is suddenly applied, with the result that, instead of the rope gradually adapting itself to the required pull, it is subjected to the jerk arising from the full inertia of the load. Lifting tests made on wire ropes, attached to chains having from 2½ in. to 12 in. of slack, show that when loads are applied suddenly, the stresses are from one to four times as great as those sustained when the same loads are gradually applied. Therefore, care should be taken to avoid, as far as possible, such pulls and jerks.

Wire-Rope Lubrication

When a complaint is made that a wire rope has not given satisfactory service, the first questions asked by the manufacturer are: "How was the rope lubricated?" "What is the condition of the inside wires?" These questions arise because the experienced wire-rope maker fully appreciates that a wire rope is a complex piece of machinery and knows that the importance of proper lubrication is too often overlooked. Sometimes a wire rope is covered with a compound too thick to penetrate beyond the outside wires. The effect of this is to leave the inside strands without protection against water and moisture.

Examinations of ropes that have fallen short of the period of good service, frequently show the outside wires to be in apparently good condition, while the areas of the inside wires have been materially reduced and the whole rope weakened. This is due to corrosion that could have been prevented by the use of a lubricant which would have reached and protected the inside wires.

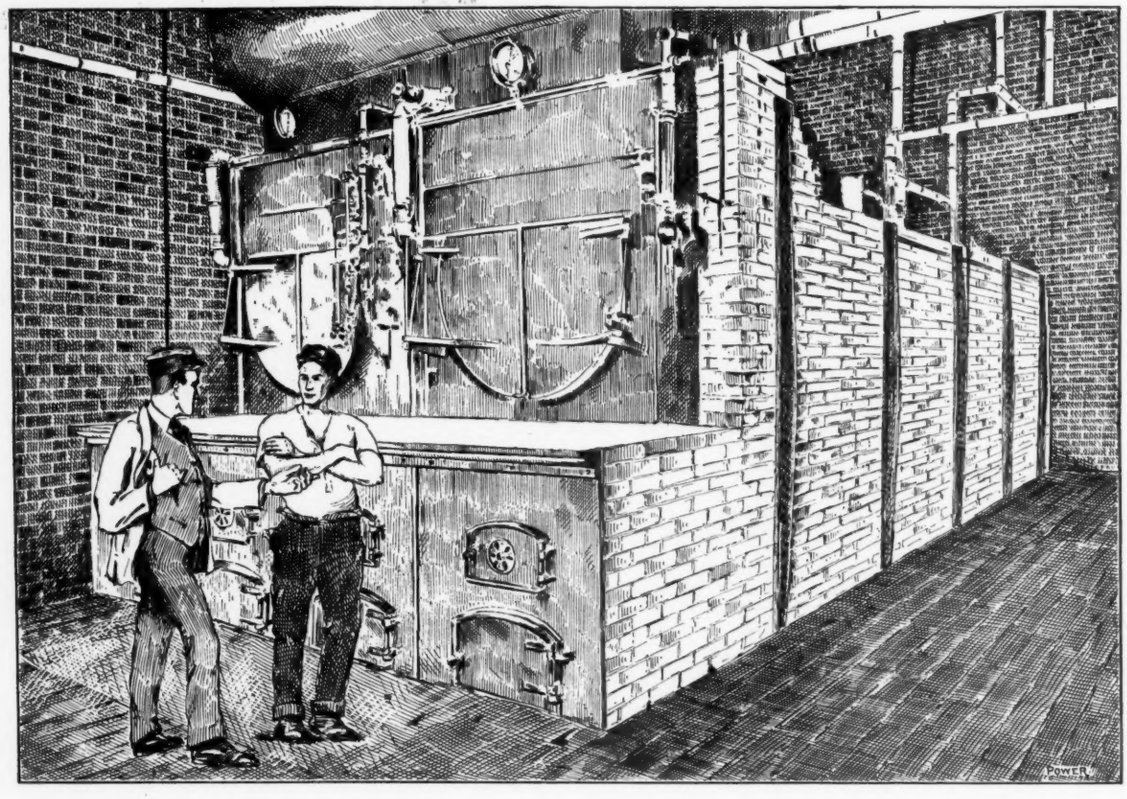
A lubricant or preservative should not only penetrate to the hemp center, in order to saturate it and prevent absorption of water, but it should also coat thoroughly the inside wires of each strand. This cannot be expected from thick, heavy and sticky compounds or the greases frequently used for the lubrication of wire ropes, which were made primarily for some other and quite different purpose.

The Dutch-Oven Furnace

By J. E. Fulweiler

"What gave you the idea of building a box for a furnace in front of these boilers?" asked the fireman of the engineer, who had dropped in to see how matters were going on in the boiler room.

"It started this way," replied the engineer, as he tapped the bowl of his favorite pipe on the heel of his shoe. "The boss had been after me for some time to stop making so much smoke, as the town authorities



"What's the Joke?" Asked the Incredulous Fireman, "You Move the Fire away from the Boiler and Lose a Lot of Heat and Then Say You Have Improved Things."

were after him hard. I couldn't see much harm in smoke, but just to please him I tried several schemes to prevent it, and did cut it down considerably. But when the peak load came on, the smoke would pour out of the top of the stack as usual.

"About that time I decided to go to night school and see if I could learn anything from the dudes over there. The chemical part was interesting, and I began trying to solve the smoke problem on my own hook. I got busy studying, and gradually got what I was after."

"Well, you moved the fire away from the boiler tubes out in this dutch-oven thing, that's sure," replied Sam with a dissatisfied grunt.

"That is right, but have you noticed that you are not shoveling as much coal into the furnace as you did before the change, and that there is hardly any smoke?"

"No," said Sam, "I have been so busy getting used to the thing, but I guess you are right about the coal and smoke, but we haven't had much of a load on this morning."

"As a matter of fact," said the engineer, "we have both machines working as hard as they can, and the test run yesterday showed a big increase in economy."

"What's the joke?" asked the incredulous fireman, "you move the fire away and lose a lot of heat and then say you have improved things."

"That's right," answered the engineer, "the bituminous coal we are using is composed of moisture, carbon, ash and what are called hydrocarbons or volatile matter. This volatile matter is what you see burning with the long, red flame. The carbon itself burns with a short, colorless flame. The volatile is driven off as a gas from the fresh coal and burns first, then the coal becomes coke and burns with a colorless flame."

"Do you mean to say that the only difference between coal and coke is that coal contains gas and that coke does not? How do you explain it, then, that coal is so much heavier than coke; doesn't gas weigh less than nothing?"

"The coal we are using has, by weight, 5 per cent. moisture, 27 per cent. volatile carbons, 58 per cent. fixed carbons and 10 per cent. of ash. Coke contains about 87 per cent. fixed carbon, 12 per cent. ash and 1 per cent. sulphur. As regards gas not weighing anything, you are probably comparing it to air, which you assume has no weight.

"You would not say that cork has no weight, yet it will float to the surface if submerged in water, because it has less weight than, or one-fourth the specific gravity of water. Gas moves up in air for the same reason, because it is lighter than air. If you take a large bottle and pump the air out, and weigh the bottle on a sensitive scale and then weigh it when filled with gas and then filled with air, you would find that the gas and air had weight. In fact, 13.1 cu.ft. of air at 60 deg. F. and 14.7 lb. abs. pressure weighs 1 lb. As the temperature is increased, if the air is not inclosed, it will expand and, therefore, weigh less per cubic foot. That is the reason why hot air will rush up the stack into the cooler air

"Volatile gases are consumed by the chemical action of the oxygen in the air while at high temperatures, but are not affected in the same way when the temperatures are reduced. Carbon and hydrogen, in various proportions, are the constituents of the volatiles, and they combine with oxygen to form water vapor, carbon monoxide and lampblack, or carbon dioxide, depending on the proportion and temperature of the available oxygen.

"The two most common causes for poor combustion are insufficient available oxygen and premature cooling of the flames. You may understand about the necessity of a proper supply of air, but you evidently haven't noticed the effect of cooling the flames prematurely. The trouble is that if the temperature of the combustion space is low the chemical action is retarded, and, instead of the carbon and oxygen uniting to form the products of combustion, as carbon dioxide, they will partly go to form carbon dioxide and carbon monoxide, and part will separate as carbon or lampblack.

"You cannot see the carbon monoxide going to waste, but fortunately you can see the carbon which shows as smoke."

"Then," remarked Sam with evident surprise, "smoke is part of the coal going to waste."

"Yes, you are right, and when you see smoke you may be sure that some carbon monoxide is going to waste."

"But," Sam inquired, "I don't quite get you on that last. What good is that stuff?"

"That is the important part," answered the engineer. "The loss of the carbon monoxide is where the real waste occurs. If the temperature surrounding the flame is kept high and the proper supply of air is given, this carbon monoxide would have burned to carbon dioxide, which would have produced additional heat in the furnace. It is for that reason that we moved the grate out into dutch ovens or boxes as you call them, so that the radiant heat will be reflected down from the arch instead of being absorbed by the tubes overhead, thus keeping the temperature of the combustion chamber high and giving those long-flamed gases a chance to be consumed before coming in contact with the comparatively cool tubes. The carbon that is left in the coke burns much in the same manner as coal, partly to carbon monoxide and partly to carbon dioxide. The carbon monoxide, however, burns to carbon dioxide when the proper supply of air comes into contact with it.

"With coke or anthracite coal the combustion is practically complete to within a few inches from the surface of the fire, so the extension furnace is not quite so essential."

Power from the Sun

In commenting upon a remark by the *Scientific American,* to the effect that "The capture of the sun's heat has been attempted, but on a very small scale, and by an ineffective method," Frank Shuman, of Tacony, Philadelphia, whose experiments in the direction of absorbing the heat from the sun in low-pressure boilers have been referred to several times in POWER, says: "Our sun-power plant of 1911 turned 43 per cent. of the heat of the sun which reaches the earth's surface into steam, and our present plant, tested during the end of August, 1913, turned 57 per cent. into steam, an improvement of 14 per cent. in two years. This record should encourage us in thinking that during the next ten years we shall be able to reach the 75 per cent. efficiency of the best modern steam boiler, and thereafter possibly surpass it." [The best modern steam boiler now does over 80 per cent.—ED.].

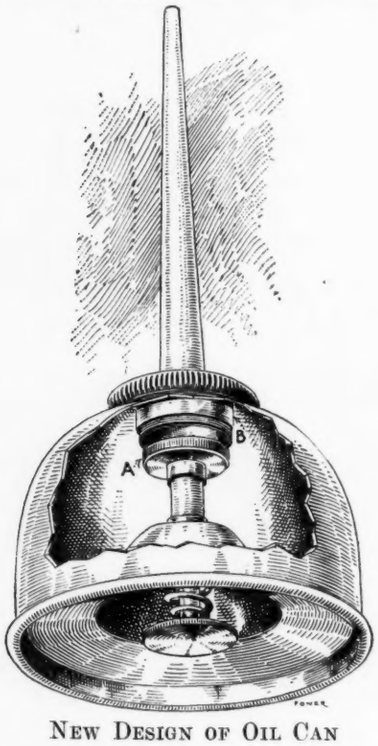
The sun's heat absorbers at Cairo occupy less than an acre of space, and develop 50 b.hp. throughout a 10-hr. day. The area of sunlight intercepted is only 13,269

sq.ft., or less than one-third of an acre, but it is necessary to place the heat-absorber units sufficiently far apart so that they will not shade each other in the forenoon and late afternoon. On the above basis it would be necessary to cover 20,250 square miles of ground in the Sahara Desert, with the sun heat-absorbing units spaced as wide apart as they are now to give perpetually the 270,000,000 hp. required to equal that which would be produced by all the fuel mined in 1909. The area of 20,250 square miles is practically equal to a square of 143 miles on the side, which is only a very small part of the Desert of Sahara, from which Mr. Shuman argues that the sun power can take care of the human race for all time.

In reply to the question, "How much will it cost to do this?" he gives the startling figure of $98,500,000,000. A well informed and independent engineer estimates the cost of construction and erecting of the 50-hp. sun-heat absorbers referred to above at $7600. The above figure is obtained by proportion from this result. "Having planted the desert with sun-heat absorbers at a cost of ninety-eight odd billion dollars," says Mr. Shuman, "we have a plant that is worth as much as all the coal and oil fields in the world, because it can perpetually give as much heat and power as all of the coal fields and oil fields of the world put together, if mined at the 1909 rate, and they are certainly worth very much more than ninety-eight odd billion dollars."

Will Oil Can

The Will oil can, illustrated herewith, is made of pressed steel, with the exception of the shaft connecting the plunger or piston with the button, which is operated by the thumb. The bottom of the can is of stiff steel.



NEW DESIGN OF OIL CAN

This can, made by the Will Manufacturing Co., 1742 Monadnock Block, Chicago, Ill., is operated by pressing the button in the center of the bottom, as with the flexible-bottom or air-cushion can.

This button is connected with a piston, packed with leather, by means of a shaft incased in a tube that fits into an oil-tight cup at the top, which effectually prevents oil from running out the spout.

The piston or plunger *A* is forced into the cylinder *B*, which is a part of the spout on the inside of the can, and forces the oil out. Thick oil can be readily fed through the spout as the tendency to clog is eliminated.

Recent Court Decisions

Digested by A. L. H. STREET

Municipal Regulation of Electric Power Rates—The law enacted by the Missouri legislature in 1913, vesting power in the Public Service Commission to fix rates for service afforded by public utilities, was lately held by the Missouri Supreme Court to have nullified an ordinance of the city of St. Louis which prescribed a maximum rate for electric current. In reaching this decision, in the case of the Union Electric Light & Power Co. vs. the City of St. Louis, the Supreme Court touched upon the regulatory powers of cities. The ordinance in question prescribed a maximum rate of 9½c. per kw.-hr. for electric current, and declared that all electric companies should be bound by certain "regulations," including a requirement that meters be furnished free of cost and a prohibition against contracts binding consumers not to use other means than electricity for light or power, or to use current for a longer period than one month, or to use a certain quantity of current, etc.

The attorneys representing the city conceded that it was beyond the power of the city to establish a maximum rate for electric service, as a "regulatory" measure, but insisted that the other provisions just mentioned were valid as tending to protect the public against any "improper or harmful manner in which the service might have been rendered," and, hence, were within the proper exercise of the police power of the city. Meeting this contention, Justice Bond, speaking for the Supreme Court, said: "We cannot assent to that view. An analysis of the various regulations contained in the ordinance discloses that each and all of them relate to the question of the price at which the plaintiff might sell its electric current, and do not touch even remotely upon the health, morals, and welfare of the public, or the conservation of its property, or upon any subject falling within the just protection of the police power of the city. Take for instance the requirement of free meters; that was evidently designed to bring within the maximum rate all expense attendant upon securing the service of electricity. In other words it was the intention of the framers of the ordinance that all meter cost should be absorbed in the maximum rate of charge. That regulation bore no possible relation to any matter lying within the just domain of the police power.

"The same may be said of the regulation as to lamp renewals without cost to the consumer. The other regulations related to restrictions upon the power of the plaintiff to make contracts with its consumers for the purpose of securing the payments of its charges; such regulations are not only outside the police power, but they are in contravention of the Constitution, which guarantees to the citizens the right of freedom of contract as to any lawful subject matter. * * * As the city had no power under its charter to fix any rate of charge for the use of electricity, it necessarily was without charter power to affect the price at which it was sold to the public by regulatory provisions contrived solely to that end, for that would be pro tanto a fixing of the price, and this, as has been seen, it had no charter power to do."

The court found that a law which expressly conferred power on the city of St. Louis to fix rates for electric current was repealed by the Public Service Commission law above mentioned.

Power Privileges in Deeds—The permanent nature of provision in deeds for power privileges as an appurtenance to the land conveyed was involved in the case of Miller vs. Clary (103 "Northeastern Reporter," 1114), which was recently before the New York Court of Appeals. Many years ago, a flour-milling company at Seneca Falls owned a tract of land upon which its mill was situated. It subdivided part of the tract into lots and sold them under deeds which bound the company to furnish "sufficient power (subject to the elements) from a wheel in the Old Stone Mills to turn a shaft and propel machinery in the basement of any building to be erected on the premises hereby conveyed, not requiring more than 15 hp."

etc. The milling company bound itself to keep the wheel in good condition and to maintain the shaft to the line of the lots conveyed. The power was furnished according to the deeds for several years, but later its transmission was suspended and the appliances for conveying it were destroyed by the elements or otherwise. All the land involved passed into the hands of purchasers and the question recently arose as to what were the rights of the present owners of the lots against the owner of the old mill property on which an electric-power plant is now in operation, in which plant there are water-wheels. On these facts, the Court of Appeals holds that the grant of "sufficient power . . . to turn a shaft," etc., was permanent in the sense that it passed to successive purchasers of the lots; not being personal to the original purchasers, and, hence, they are entitled to have power supplied to them according to the deed. But the court holds that the clause requiring the grantor to construct and maintain the shaft was personal to him, and was not binding upon his successors in ownership. Accordingly the present owners of the lots must bear the expense of reconstructing and maintaining the shaft.

Right to Use water for Mill Pond—An owner of land adjacent to a mill pond, under a deed giving title to one-half the bed of the stream, is entitled to a reasonable use of the water in the mill pond, for use in generating power, if the rights of the mill-dam owner are not thereby impaired to a material extent. (Georgia Supreme Court, Rome Ry. & Light Co. vs. Loeb, 80 "Southeastern Reporter," 785.)

An Unusual Boiler House

Built as part of Boston's new nine-million-dollar port development, the boiler house on the Commonwealth fish pier has some unusual features, consisting as it does of three distinct structures within the four walls. For various reasons, including a delay in the delivery of structural steel, the reinforced-concrete walls of this building were put up and completed by the Aberthaw Construction Co., Boston, before the steel was on the ground. The structural members have been erected inside the walls to carry the floors and the huge coal pocket, and are independent completely of the walls themselves. The third structure, which also is of reinforced concrete, is the big chimney located in the building near one corner.

The outside dimensions of the concrete structure are 56 ft. 6 in. by 70 ft., with a height above the ground floor of 79 ft. This structure is virtually an enormous concrete box without internal bracing of any sort. It is not tied together by the structural members, as would have been the case under ordinary conditions of erection. It is constructed wholly of concrete with steel reinforcing bars, there being no structural steel members embedded in the concrete, either for wall columns or wall beams. All of these are of reinforced concrete only, giving the outside of the building something of a lattice-work effect on a huge scale—an effect which is enhanced by the almost total absence of windows and other openings.

BOOKS RECEIVED

THE ENGINEERING INDEX ANNUAL. By the "Engineering Magazine," New York. Cloth; 508 pages, 6½x9½ in. Price, $2.

HOW TO BUILD UP FURNACE EFFICIENCY. By Jos. W. Hays, Rogers Park, Chicago, Ill. 7th edition; paper; 126 pages, 5x7¼ in.; illustrated. Price, $1.

INDUSTRIAL CHEMISTRY. By Henry K. Benson. The Macmillan Co., New York. Cloth; 431 pages, 5x7½ in.; illustrated; tables.

THE EFFICIENT MAN. By Thomas D. West. The Gardner Printing Co., Cleveland, Ohio. 330 pages, 5x7½ in.; illustrated. Price, $1.50.

NEW PUBLICATIONS

THE ENGINEERING INDEX ANNUAL, 1913; 508 pages; 6x9; cloth; The Engineering Magazine Co., New York; price, $2.

The volume of engineering literature produced is such that it is a serious task, even with the specialist, to keep up with the contributions to his particular field of activity. Such an index as that published monthly by the "Engineering Magazine" serves a very useful purpose to the intelligent user, and when these indexes are aggregated into yearly volumes one has an indication of and direction to everything of moment which has appeared upon any engineering subject in the period of time covered by the index, in about 250 publications, representing 17 nations and colonies, and six languages. The latest volume brings the investigator down to the December, 1913, issue of the Engineering Index in the "Engineering Magazine, covering the serial literature of engineering up to October, 1913.

International Engineering Congress, 1915

Rapid progress is being made in working out the final program of papers for the International Engineering Congress to be held in San Francisco in 1915.

The first volume of the publication of the Congress will consist of a series of articles descriptive of the various technical features of the design and construction of the Panama Canal. This will include 22 topics each of which will be treated by an engineer who has been responsible for the design and construction described. The introductory chapter as well as the topic of "Dry Excavation for the Panama Canal" will be handled by Colonel Goethals himself.

This volume will constitute practically an official technical record of the gigantic engineering feat which is just nearing completion and will be of interest, not only to engineers but to laymen.

No similar volume has as yet been prepared upon the canal, nor is it probable that any such will be in the future. The advantage is being taken of the congress to draw together under one cover in this way, the statements of the men who have been responsible for the work.

The program of papers for the various sections of the congress is practically completed and notices of them will be published in the near future. Subscriptions to the congress are being received daily and on Mar. 1 the number of enrollment was slightly in excess of 1200, of which over 200 are from foreign countries and about 1000 from the United States. Subscription blanks have been mailed through the various national societies to many thousands of engineers in this country and through the foreign societies to foreign engineers. The response already received is very encouraging, but it is trusted that all engineers interested in the success of the congress will not fail to send in their subscriptions as early as possible. Delay in so doing renders the task of the committee of management more difficult, and makes it impossible to form any just estimate of the receipts which may be expected and the number of copies of the volumes which have to be published. E. J. Dupuy, Foxcroft Building, San Francisco, Calif., is the executive secretary.

OBITUARY

GEORGE WESTINGHOUSE

George Westinghouse, the well known inventor and engineer, died of heart disease at his New York City residence on Mar. 12. His health had been failing for some time, and during the past year or two, he had withdrawn from active participation in many of the industries with which he had long been associated.

Born at Central Bridge, N. Y., Oct. 6, 1846, he attended the public schools of that town, spending much of his leisure time in his father's machine shop. This early practical experience proved of inestimable value in later life when working out the details of many of his inventions. He later moved to Schenectady where his father engaged in the manufacture of agricultural machinery.

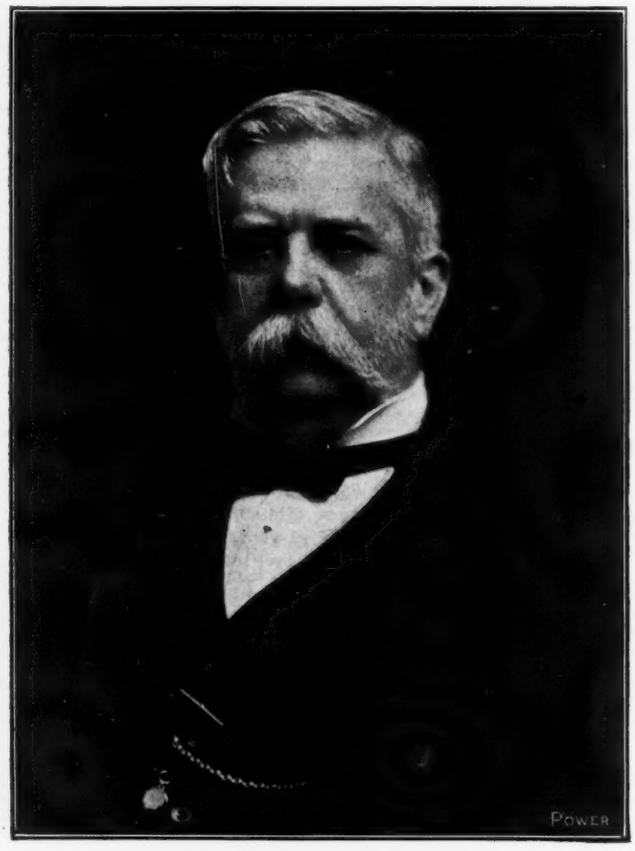
At the age of 17 he enlisted for the Civil War in the New York National Guard, and later entered the navy as third assistant engineer, where he saw service with the Potomac flotilla. Returning at the close of the war, young Westinghouse entered Union College, where he remained until the end of his sophomore year. He abandoned classical studies, however, for active life to find a wider scope for his inventive genius.

One of his first inventions was a rerailing frog. The idea of this was suggested one day upon returning from a trip to Albany when the train was delayed by the derailing of a freight train ahead. He returned home, made some frogs, and with two other men who furnished $5000, started his first factory to manufacture the invention. He held the patent in his own name, however. When the device was on the market the partners demanded that he make over the patents to them. Westinghouse refused, and the partners seized the business, which without the young inventor soon failed. He then went to Pittsburgh, where he became a salesman for

Alexander & Woods, a steel-casting company. This firm took up the rerailing frog and made it a success.

About this time on a trip to Troy, he witnessed a bad train wreck, due primarily to failure of the handbrakes to operate in time. The idea occurred to him that a brake under the control of the engineer could have prevented the accident. He thereupon set about to devise such a brake, evolving first an automatic brake attached to the couplers; but this was unsuccessful, and was followed by a steam operated brake, which also proved unsatisfactory. Compressed air was next tried, and proved successful, the first patent being obtained April, 1869, and the Westinghouse Air Brake Co. was founded the following July. From this time, many changes and important improvements were made in the air brake, and Mr. Westinghouse spent seven years, from 1871 to 1882, in Europe introducing his invention and adapting it to meet European railroad conditions.

About 1880 Mr. Westinghouse became interested in the operation of railway signals and switches by compressed air,



GEORGE WESTINGHOUSE

and soon after developed and patented the system now manufactured by the Union Switch & Signal Co.

Six years later the Westinghouse Electric Co. was formed for the manufacture of lamps and electric-lighting apparatus. This grew into the Westinghouse Electric & Manufacturing Co., which now has extensive works at East Pittsburgh and employs over 22,000 people. Mr. Westinghouse was president until the panic of 1907, when the company became financially involved and in the reorganization new interests were put in control.

In 1892 he procured the contract for the electrical equipment of the World's Fair at Chicago, and a year later the contract for the large generators at Niagara Falls, both of which mark epochs in the progress of the electrical industry. He was one of the early champions of alternating-current transmission, and it was due largely to his persistent efforts in the face of strong opposition, that this system was introduced and developed in this country at the time.

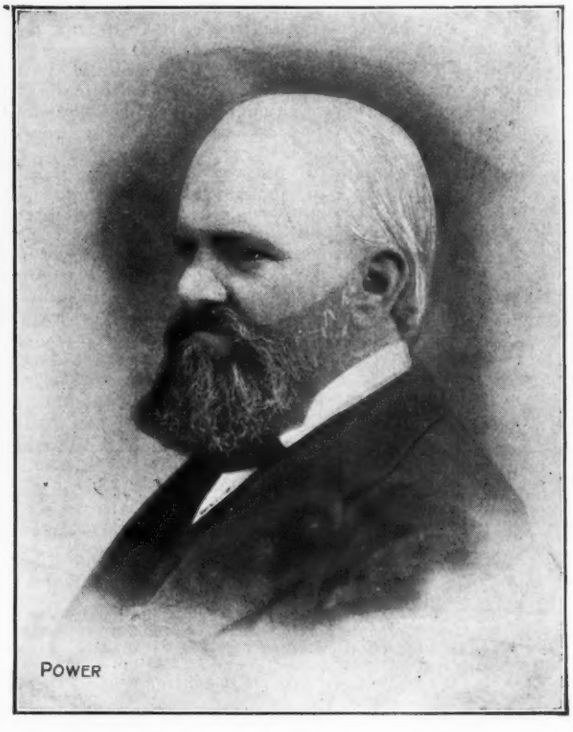
Among the companies with which Mr. Westinghouse was identified are the Westinghouse Air Brake Co., the Westinghouse Machine Co., Nernst Lamp Co., the Union Switch & Signal Co., Société Anonyme Westinghouse, of Paris, the Cooper-Hewitt Electric Co., Pittsburgh Meter Co., Societe Italiana Westinghouse, Italy, the Westinghouse Brake Co., Ltd., of London, the Westinghouse Cooper-Hewitt Co., of London, and the Westinghouse Metal Filament Lamp Co., of London. He was also chairman of the Board of Directors of the Westinghouse Electric Co., Ltd., London, and director of the Westinghouse Electric & Manufacturing Co., the Traction & Power Security Co., and the Westinghouse Metallfaden Gluhlampenfabrik, Vienna. These companies employ over 50,000 men, and have a total capitalization of $200,000,000.

Among the honors conferred upon Mr. Westinghouse in acknowledgement of his many achievements were the degree of doctor of philosophy by Union College, the French Legion of Honor, the Royal Italian Order of the Crown, and the Order of Leopold of Belgium. He was the recipient of the John Fritz medal, also the Grashof medal presented by the German engineers; an honorary member and past-president of the American Society of Mechanical Engineers, and an honorary member of the American Society.

A widow and one son survive him.

JOHN F. SHEARMAN

Older readers of "Power" will recall the contributions of Peter Van Brock. Although this was understood to be a nom de plume, he would give no other particulars regarding himself, and it is only with his decease, which occurred at Hillsdale, N. Y., on the 6th of this month, that his identity became revealed. His name was John F. Shearman, and he was born in London on July 1, 1828, coming to America in 1844. His father was John H. Shearman, a noted surgeon, and the son studied medicine, but gave it up for the study and practice of mechanical engineering. He was the inventor of numerous mechanical devices, also of a gunpowder which he sent to the James River in 1865 to demonstrate. It was at about this time that he began to write for the mechanical papers under the nom de plume of Peter Van Brock, and only recently have his contributions ceased to appear.



JOHN F. SHEARMAN
(PETER VAN BROCK)

Thomas G. Shearman, deceased, of the law firm of Shearman & Sterling, in New York City, and James A. Shearman, an artist, of Switzerland, are brothers. In 1905 John F. Shearman moved to Jefferson, Iowa, but returned in 1912 to end his days at Hillsdale, N. Y.

JAMES HONOR

James Honor, chief engineer at the power plant of the Altoona & Logan Valley Electric Ry., Altoona, Penn., is dead. Mr. Honor had been a resident of Altoona for the last ten years. He was born in Schuylkill County on Apr. 10, 1866, and was educated in the schools of that county, and soon afterward entered upon an apprenticeship in a machine shop. He entered the employ of the Logan Valley Ry. in 1904.